Alliance for Historic Wyoming
PO Box 51201
Casper, WY 82605

dedicated to preserving our irreplaceable & diverse historic and cultural resources

OCT 27 2011 PM 82009

Walt George, Project Manager
Gateway West Transmission Line DEIS
Bureau of Land Management
P.O. Box 20879
Cheyenne, WY 82003

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Dedicated to preserving our unique and irreplaceable historic & cultural resources

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Gateway West Transmission Line DEIS
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P.O. Box 20879
Cheyenne, WY 82003

Dear Mr. George:

Thank you for this opportunity to comment on the Gateway West Transmission Line Draft Environmental Impact Statement. Please consider these the formal comments of the Alliance for Historic Wyoming (AHW), a statewide nonprofit organization dedicated to preserving our historic and cultural resources. We work with citizens around the state and the country to ensure that Wyoming's irreplaceable historic resources exist for future generations.

In these comments, we are also being joined by Tracks Across Wyoming (TRACKS), a nonprofit which represents the six southern Wyoming counties and all of the I-80 and UPRR corridor along with significant segments of the Overland and Cherokee Trails along with the historic segments of the original Lincoln Highway. TRACKS joins AHW in expressing grave concern that our Wyoming cultural heritage is being dramatically altered by the piecemeal development from these numerous proposed projects. To date, Tracks Across Wyoming has not been involved in the Section 106 consultations on this project but they would also appreciate being included as an interested party in these discussions. Chuck Lanham <clanham@bresnan.net> can serve as the BLM's contact person for TRACKS. He is chairman of the TRACKS board and his surface mail address is P.O. Box 1442, Riverton, WY 82501.

AHW has been carefully following this project from the beginning and has also participated in the Section 106 consultations under the National Historic Preservation Act. As you know, NHPA requires federal land management agencies to "seek and consider the views of the public in a manner that reflects the nature and complexity of the undertaking and its effects on historic properties, [and] the likely interest of the public in the effects on historic properties...." 36 CFR § 800.2(d)(1) The Gateway West project has certainly been a complex

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undertaking, with wide-ranging impacts on a huge number of cultural and historic resources. In general, we believe your office has done a good job in reaching out to the public and seeking their input on this project. Unfortunately, though, the nature of this undertaking has made it impossible to avoid having significant impacts on numerous historic resources. And while the Historic Sites Act of 1935 reminds us that: "It is a national policy to preserve for public use historic sites, buildings, and objects of national significance for their inspiration and benefit of the people of the United States," we frequently discover, as with this project, that, in fact, it has also become national policy to sacrifice these resources when necessary to facilitate energy development.

The BLM has done a reasonably good job of considering the issues raised during scoping concerning this project's impacts on our historic and cultural resources. When we analyze the multiple alternate routes laid out for segments 1, 2, and 3 in the DEIS, we find that each one involves enough compromises that it is difficult to prefer route x over route y. Moreover, while we applaud the comprehensiveness of the DEIS, we find that the electronic resource is fairly difficult to work with. Unfortunately, it appears as though your office did not spend enough time considering how the general public, which will generally access this document on-line, would be able to cross-reference the multiple maps included in the appendices. For instance, the viewpoint location maps included with the visual simulations provide no geographical information by which to pinpoint the observation point's location. Going back and forth between the visual simulations and the cultural resources maps to determine the physical location was quite cumbersome, especially since there appears to be little rhyme or reason for the numbering of the key observation points. (Example: KOP C8 is located right next to C645.) There was also a problem with one of the visual simulations in that the viewpoint location map identified the site as KOP C642 while the text on the same page called this C110. (Since I never found a C110, we have assumed this was KOP C642.) In the end, we never did locate C10. It is most unfortunate that you did not take advantage of the unique opportunities technology provides to interface documents so that the concerned public would have been better able to match up the information provided. Likewise, we were frustrated to only find the listing of historic trails and stage roads on the cultural resource maps. While we appreciate the complexity of the data you were attempting to present, we feel that, in the end, you presented it in a format that would work much better for those few who were lucky enough to access the DEIS in hard copy and that you could and should have provided more accessible tools to the larger public who will access the information electronically. We hope that, in the future, you will work harder to interlink your documents so that they can be better understood and studied by the general public.

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From the beginning, we have expressed our concerns about how Segment Two would impact the Fort Fred Steele area. Your preferred alternative appears to provide as much protection as possible for this historic area. We appreciate your attention to this often overlooked resource area.

Section Three gives us fewer concerns although we were somewhat disappointed to find no substantive discussion of the impact of this new line on Point of Rocks Stage Station. Unfortunately, Point of Rocks receives very little attention from cultural resource managers although it is ideally situated directly on the I-80 corridor and could be better promoted by the state as a point of interest for heritage tourists. Many people regard this site as already so severely impacted by the I-80 corridor that it deserves little notice. However, once you take the time to get off the interstate and begin exploring the stage station and its nearby environs, including the short segments of accessible trail that lead to the small nearby cemetery, you discover a rather delightful historic area. The addition of these transmission lines will, of course, further industrialize this area, making future appreciation of this isolated site even more difficult.

From the very beginning, our primary concerns have been with Segment 4 and the impact that this transmission line will have on the lovely Sublette Cutoff as well as the Slate Creek Cutoff. While we appreciate that your preferred alternative does not do as much damage as some of the other alternatives (notably, Alternative 4A), the visual simulations from KOPs C57 and C40 are truly heartbreaking and show exactly what the public will be giving up for this project. Additionally, we are sorry that you chose not to provide any visual simulations from any of the numerous cultural KOPs identified around Seedskadee National Wildlife Refuge. The traces from the emigrant era of the treacherous crossing of the Green River in this area are quite remarkable and we regret having no visual information to inform us as to how these transmission lines will affect that impressive historic district.

We are also disappointed to discover that there are no visual simulations from Alternatives 4B, 4C or 4D. 4D remains our preferred route through this fragile environment but we would feel much more sanguine about that choice if we had seen visual simulations from these more southerly alternatives. Your decision to provide visual simulations from such a limited number of cultural KOPs in Segment 4 - the most delicate of the project areas in Wyoming - is difficult to understand unless the decision to utilize either the preferred alternative or Alternative 4A has already been made. We know that there has been considerable input from trails

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We are also extremely concerned about the cumulative effects of this undertaking on our cultural resources. We do not feel as though you have thoroughly considered how these cumulative impacts to our National Historic Trails impact this resource. We disagree most sincerely with your "definition of cumulative impact area" for these historic trails. While you acknowledge that, where setting is a component of eligibility, the cumulative impacts will be considered for a five mile wide buffer area, you do nothing to address how the increasing segmentation of these trails affect the resource as a whole. Unfortunately, the Bureau of Land Management has become very adept at viewing these linear resources through a very fragmented lens. When the BLM talks about "areas of potential effect" or "cumulative impact areas," they usually define this as beginning and ending within the boundaries of any given project. Unfortunately for this particular resource - and those people who love it - this is a very cramped way of understanding the historic emigrant trails. We all understand that the historic trails are long, linear, contiguous resources. Their very historic nature comes from the fact that people embarked on their journey at one spot and followed these roadways for hundreds and hundreds of miles. When we artificially decide that an "area of potential effect" begins and ends within the boundaries of a designated undertaking, we are completely disregarding the actual nature of these spectacular and unique historic properties. We understand the logic of treating discrete historic and cultural sites as being with a defined "area of potential effect" that may exist solely within the boundaries of a specific undertaking but thinking makes little to no sense when it comes to handling linear resources such as the National Historic Trails. When you damage the Sublette Cutoff in Wyoming, the full lengths of the Oregon and California National Historic Trails are damaged. Every time a stretch of these remarkable resources are compromised, we make it that much more difficult to fully appreciate the hazards endured by those courageous emigrants. We in Wyoming are blessed with the best remaining remnants of these NHTs; yet, our actions are rapidly degrading this unique resource. And when we talk about the trails as if they exist in discrete segments, separated from their whole, we are further encouraging this segmentation and degradation. This sort of analysis should be especially evident in the "cumulative effects" section of your analysis. Yet, we find that it is pretty much nonexistent. We strongly encourage you to undertake a more complete analysis of the cumulative impacts to the National Historic Trails of not only this particularly undertaking but also how the trails are being impacted by all of the industrialization of the Wyoming historic landscape that has occurred in this area in the last 5-10 years as well as the additional industrialization that is looming on the horizon. What is our obligation to preserve these amazing ruts and swales and what actions are we taking to ensure that our descendants will also have the opportunity to walk in the footsteps of their adventurous ancestors in a setting that still reflects the mid-1800s landscape? Wyoming may be the last frontier where it will be possible to recreate this experience. If we allow industrialization to strip that opportunity from our children and grandchildren, what do we owe them in exchange? These are questions that we simply do not

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believe you have adequately addressed in this DEIS.

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We also believe your socioeconomic impacts analysis is flawed in that it totally failed to consider the impacts that this project will have on those businesses and organizations that rely heavily on heritage tourism. In fact, we don't remember seeing "heritage tourism" discussed anywhere in this document, despite the fact that tourism is Wyoming's second largest industry and heritage tourism is its fastest growing sector. Wyoming, with its reputation as the "real West" and its vast open spaces, has long been a major beneficiary of this trend. Whole organizations, such as Tracks Across Wyoming, have arisen to cater to these special-interest tourists. But we have serious concerns about how these projects, especially when considered cumulatively, will affect the future of heritage tourism in Wyoming. I-80 is a major transportation corridor through our state. Few people expect interstates to be especially scenic but they can often provide travelers with a tempting glimpse of what is available to them with a simple detour. But what will happen if an industrial horizon is all the heritage tourist sees? What if wind turbines dominate the skyline? Will they still be tempted to take a detour off I-80 to historic Medicine Bow if all they see is these huge transmission towers heading northeast? Will they take the little detours to visit the old penitentiary or to see the wonders of Superior, WY? Superior works hard to market itself, maintaining its own website where it invites people to "enjoy a modern day voyage into yesteryear to a town forgotten by time." They call themselves "a diamond in the rough" designed for those "seeking real adventure in authentic old west sightseeing." [See: http://www.superiorwyoming.net/] Will the heritage tourist follow that call or will they simply decide that southern Wyoming has nothing left to offer but an industrial landscape? We don't know the answer to that question and we are disappointed that you did not attempt to answer it, either. We encourage you to look much more deeply into how these cumulative effects will impact the heritage tourism industry that sustains so many of these little Wyoming towns.

Another concern we have is ensuring that your final EIS address the need for improved in-house training for heavy equipment field operators working in proximity to the National Historic Trails. In the last few years, we have witnessed several instances where field operators have failed to recognize existing remnants of the historic emigrant trails and, as a result, sections of those irreplaceable historic trails have been lost forever. While better marking of these trails can improve this situation, we believe that it is especially important that field operators are well-trained in regards to their obligations under both NHPA and the Archaeological Resources Protection Act (ARPA). NHPA requires that: "Each Federal agency that is responsible for the protection of historic resources, including archaeological resources...shall ensure" [16 U.S.C. 470h-4(a)] that "All actions taken by employees or contractors of such agency shall meet professional standards under regulations developed by the Secretary...and the appropriate professional societies of the disciplines involved, specifically archaeology, architecture, conservation, history, landscape architecture, and planning." [16 U.S.C. 470h-4(a)(1)]

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ARPA, likewise, gives strong guidance on these issues, noting: "Archaeological resources on public lands and Indian lands are an accessible and irreplaceable part of the Nation's heritage, and these resources are increasingly endangered because of their commercial attractiveness." [16 U.S.C. 470aa] According to 16 U.S.C. 470ee(a), no person may alter or deface any archaeological resource located on public or Indian lands unless pursuant to a legally issued permit, with the exception of surface arrowheads. Any person who knowingly violates this law faces penalties defined in 16 U.S.C. 470ee(d). Together, these provisions from NHPA and ARPA make it clear that contractors working on any federal undertaking where they may encounter cultural resources needs to receive in-depth training regarding the significance of those resources and the contractor's responsibilities under the law. While the DEIS addresses some of the concerns that result from increased access to historic and cultural resources and the resultant potential for increased vandalism, we are concerned that the DEIS does not lay out any proposed actions to protect these resources from this kind of damage. Therefore, we do hope your FEIS will include significant requirements for training heavy equipment operators. If, at any time, you feel that AHW can be of assistance in explaining the importance of these resources to the contractors and equipment operators, please feel free to contact us.

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We also want to emphasize the importance of developing a comprehensive monitoring and cultural resource discovery plan for this project. A wide variety of these plans are in existence, some better than others. However, it is vital that a comprehensive plan be available for review by the general public and that it also be thoroughly vetted by those involved in the Section 106 discussions. We believe it should also be prominently attached to all future NEPA documents on this project. Only with an accepted and well understood comprehensive monitoring and cultural resource discovery plan can you ensure that any unexpected discoveries encountered during the course of this project are handled properly. This is especially true whenever you are working around prehistoric archaeological sites or the emigrant trails because of the strong potential for uncovering human remains. This is especially important not only to ensure proper compliance with NAGPRA but also because Wyoming currently lacks a comprehensive state statute regarding the discovery of human remains.

Finally, we note that, of all the resource types considered and addressed in this document, cultural resources are the **only** resource that the BLM concludes would suffer "significant adverse effects" from the Gateway West project alone:

> Gateway West, by itself, would have significant adverse effects on some cultural resources, particularly on historic properties for which visual setting is important like historic trails. When considered together with other past, present, and foreseeable future projects, including additional transmission lines, the cumulative effect is also significant. Similarly, the visual impact of the Gateway West set of lattice towers in some areas would be a substantial negative effect, and when taken together with the several proposed transmission lines and other developments, would form a cumulatively

considerable adverse impact. (pp. ES-24-25)

This is obviously reason for great concern, especially since we do not agree with your conclusion that the Sec. 106 process under NHPA is capable of addressing all of the adverse impacts this project will bring with it. The limitations on Section 106 negotiations - from the cramped understanding of "areas of potential effects" described above to the requirement that mitigation be done "on-site" - has increasingly made this process incapable of adequately addressing the level of cumulative disruption we are seeing to our historic and cultural resources, especially our historic emigrant trails. The Section 106 process is capable of addressing limited impacts from the project itself, i.e., necessary on-site mitigation within the area of potential effect. But the Section 106 process is simply inadequate to address the cumulative effects of these projects. With cultural resources being the only identified resource to suffer "significant adverse effects" from Gateway West itself, we do not believe that Section 106 will be sufficient to address the cumulative impacts anticipated by the DEIS, let alone the larger issues of landscape industrialization that we believe are inherent in this project.

Therefore, we sincerely request that the BLM require additional off-site compensatory mitigation for the acknowledged adverse impacts to irreplaceable historic and cultural resources resulting from this undertaking. We note that the proponents have already offered such mitigation to compensate for potential loss of wildlife habitat and that the BLM is considering mitigation for those losses above and beyond what has already been volunteered. We believe that this same sort of consideration for cultural resource losses is equally appropriate, considering the inherent limitations of the Section 106 process. The Jonah Interagency Office, established as a result of the Pinedale Anticline Record of Decision, offers a template for the kind of off-site compensatory mitigation we would like to see established for cultural resources as a result of this project.

As I am sure you know, Congress declared in NHPA that "the historical and cultural foundations of the Nation should be preserved as a living part of our community life and development in order to give a sense of orientation to the American people; [and] the preservation of this irreplaceable heritage is in the public interest so that its vital legacy of cultural, educational, aesthetic, inspirational, economic, and energy benefits will be maintained and enriched for future generations of Americans." 16 U.S.C. 470(b)(2) and (b)(4) Moreover, NHPA states that: "It shall be the policy of the Federal Government...to foster conditions under which our modern society and our prehistoric and historic resources can exist in productive harmony and fulfill the social, economic, and other requirements of present and future generations; [and] encourage the public and private preservation and utilization of all usable elements of the Nation's historic built environment." 16 U.S.C. 470-1 (1) and (5) These findings place a high burden on our country's land management agencies to ensure that all possible steps be taken to ensure the protection of our historic and cultural resources for future generations.

Thank you for your consideration of these comments. Should you have any questions about our concerns, please feel free to contact us. The Alliance for Historic Wyoming and Tracks Across Wyoming look forward to working with you as this project proceeds.

Sincerely,

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Lesley Wischmann
Founding Board Member
Alliance for Historic Wyoming

Charles "Chuck" Lanham
Board Chairman
Tracks Across Wyoming

Lesley Wischmann
<lesleywisch@wyoming.com>

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To Gateway_West_WYMail@blm.gov
cc
bcc
Subject comments of Alliance for Historic Wyoming and Tracks Across Wyoming

Attached please find our comments on the Gateway West project. We will also be submitting these via surface mail.

Thank you.

AHW project comments.doc

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We are also disappointed to discover that there are no visual simulations from Alternatives 4B, 4C or 4D. 4D remains our preferred route through this fragile environment but we would feel much more sanguine about that choice if we had seen visual simulations from these more southerly alternatives. Your decision to provide visual simulations from such a limited number of cultural KOPs in Segment 4 – the most delicate of the project areas in Wyoming – is difficult to understand unless the decision to utilize either the preferred alternative or Alternative 4A has already been made. We know that there has been considerable input from trails

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believe you have adequately addressed in this DEIS.

We also believe your socioeconomic impacts analysis is flawed in that it totally failed to consider the impacts that this project will have on those businesses and organizations that rely heavily on heritage tourism. In fact, we don't remember seeing "heritage tourism" discussed anywhere in this document, despite the fact that tourism is Wyoming's second largest industry and heritage tourism is its fastest growing sector. Wyoming, with its reputation as the "real West" and its vast open spaces, has long been a major beneficiary of this trend. Whole organizations, such as Tracks Across Wyoming, have arisen to cater to these special-interest tourists. But we have serious concerns about how these projects, especially when considered cumulatively, will affect the future of heritage tourism in Wyoming. I-80 is a major transportation corridor through our state. Few people expect interstates to be especially scenic but they can often provide travelers with a tempting glimpse of what is available to them with a simple detour. But what will happen if an industrial horizon is all the heritage tourist sees? What if wind turbines dominate the skyline? Will they still be tempted to take a detour off I-80 to historic Medicine Bow if all they see is these huge transmission towers heading northeast? Will they take the little detours to visit the old penitentiary or to see the wonders of Superior, WY? Superior works hard to market itself, maintaining its own website where it invites people to "enjoy a modern day voyage into yesteryear to a town forgotten by time." They call themselves "a diamond in the rough" designed for those "seeking real adventure in authentic old west sightseeing." [See: http://www.superiorwyoming.net/] Will the heritage tourist follow that call or will they simply decide that southern Wyoming has nothing left to offer but an industrial landscape? We don't know the answer to that question and we are disappointed that you did not attempt to answer it, either. We encourage you to look much more deeply into how these cumulative effects will impact the heritage tourism industry that sustains so many of these little Wyoming towns.

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Another concern we have is ensuring that your final EIS address the need for improved in-house training for heavy equipment field operators working in proximity to the National Historic Trails. In the last few years, we have witnessed several instances where field operators have failed to recognize existing remnants of the historic emigrant trails and, as a result, sections of those irreplaceable historic trails have been lost forever. While better marking of these trails can improve this situation, we believe that it is especially important that field operators are well-trained in regards to their obligations under both NHPA and the Archaeological Resources Protection Act (ARPA). NHPA requires that: "Each Federal agency that is responsible for the protection of historic resources, including archaeological resources...shall ensure" [16 U.S.C. 470h-4(a)] that "All actions taken by employees or contractors of such agency shall meet professional standards under regulations developed by the Secretary...and the appropriate professional societies of the disciplines involved, specifically archaeology, architecture, conservation, history, landscape architecture, and planning." [16 U.S.C. 470h-4(a)(1)]

ARPA, likewise, gives strong guidance on these issues, noting: "Archaeological resources on public lands and Indian lands are an accessible and irreplaceable part of the Nation's heritage, and these resources are increasingly endangered because of their commercial attractiveness." [16 U.S.C. 470aa] According to 16 U.S.C. 470ee(a), no person may alter or deface any archaeological resource located on public or Indian lands unless pursuant to a legally issued permit, with the exception of surface arrowheads. Any person who knowingly violates this law faces penalties defined in 16 U.S.C. 470ee(d). Together, these provisions from NHPA and ARPA make it clear that contractors working on any federal undertaking where they may encounter cultural resources needs to receive in-depth training regarding the significance of those resources and the contractor's responsibilities under the law. While the DEIS addresses some of the concerns that result from increased access to historic and cultural resources and the resultant potential for increased vandalism, we are concerned that the DEIS does not lay out any proposed actions to protect these resources from this kind of damage. Therefore, we do hope your FEIS will include significant requirements for training heavy equipment operators. If, at any time, you feel that AHW can be of assistance in explaining the importance of these resources to the contractors and equipment operators, please feel free to contact us.

We also want to emphasize the importance of developing a comprehensive monitoring and cultural resource discovery plan for this project. A wide variety of these plans are in existence, some better than others. However, it is vital that a comprehensive plan be available for review by the general public and that it also be thoroughly vetted by those involved in the Section 106 discussions. We believe it should also be prominently attached to all future NEPA documents on this project. Only with an accepted and well understood comprehensive monitoring and cultural resource discovery plan can you ensure that any unexpected discoveries encountered during the course of this project are handled properly. This is especially true whenever you are working around prehistoric archaeological sites or the emigrant trails because of the strong potential for uncovering human remains. This is especially important not only to ensure proper compliance with NAGPRA but also because Wyoming currently lacks a comprehensive state statute regarding the discovery of human remains.

Finally, we note that, of all the resource types considered and addressed in this document, cultural resources are the **only** resource that the BLM concludes would suffer "significant adverse effects" from the Gateway West project alone:

> Gateway West, by itself, would have significant adverse effects on some cultural resources, particularly on historic properties for which visual setting is important like historic trails. When considered together with other past, present, and foreseeable future projects, including additional transmission lines, the cumulative effect is also significant. Similarly, the visual impact of the Gateway West set of lattice towers in some areas would be a substantial negative effect, and when taken together with the several proposed transmission lines and other developments, would form a cumulatively

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considerable adverse impact. (pp. ES-24-25)

This is obviously reason for great concern, especially since we do not agree with your conclusion that the Sec. 106 process under NHPA is capable of addressing all of the adverse impacts this project will bring with it. The limitations on Section 106 negotiations – from the cramped understanding of "areas of potential effects" described above to the requirement that mitigation be done "on-site" – has increasingly made this process incapable of adequately addressing the level of cumulative disruption we are seeing to our historic and cultural resources, especially our historic emigrant trails. The Section 106 process is capable of addressing limited impacts from the project itself, i.e., necessary on-site mitigation within the area of potential effect. But the Section 106 process is simply inadequate to address the cumulative effects of these projects. With cultural resources being the only identified resource to suffer "significant adverse effects" from Gateway West itself, we do not believe that Section 106 will be sufficient to address the cumulative impacts anticipated by the DEIS, let alone the larger issues of landscape industrialization that we believe are inherent in this project.

Therefore, we sincerely request that the BLM require additional off-site compensatory mitigation for the acknowledged adverse impacts to irreplaceable historic and cultural resources resulting from this undertaking. We note that the proponents have already offered such mitigation to compensate for potential loss of wildlife habitat and that the BLM is considering mitigation for those losses above and beyond what has already been volunteered. We believe that this same sort of consideration for cultural resource losses is equally appropriate, considering the inherent limitations of the Section 106 process. The Jonah Interagency Office, established as a result of the Pinedale Anticline Record of Decision, offers a template for the kind of off-site compensatory mitigation we would like to see established for cultural resources as a result of this project.

As I am sure you know, Congress declared in NHPA that "the historical and cultural foundations of the Nation should be preserved as a living part of our community life and development in order to give a sense of orientation to the American people; [and] the preservation of this irreplaceable heritage is in the public interest so that its vital legacy of cultural, educational, aesthetic, inspirational, economic, and energy benefits will be maintained and enriched for future generations of Americans." 16 U.S.C. 470(b)(2) and (b)(4) Moreover, NHPA states that: "It shall be the policy of the Federal Government...to foster conditions under which our modern society and our prehistoric and historic resources can exist in productive harmony and fulfill the social, economic, and other requirements of present and future generations; [and] encourage the public and private preservation and utilization of all usable elements of the Nation's historic built environment." 16 U.S.C. 470-1 (1) and (5) These findings place a high burden on our country's land management agencies to ensure that all possible steps be taken to ensure the protection of our historic and cultural resources for future generations.

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Thank you for your consideration of these comments. Should you have any questions about our concerns, please feel free to contact us. The Alliance for Historic Wyoming and Tracks Across Wyoming look forward to working with you as this project proceeds.

Sincerely,

Lesley Wischmann
Founding Board Member
Alliance for Historic Wyoming

Charles "Chuck" Lanham
Board Chairman
Tracks Across Wyoming

Duplicate

P.O. Box 51201, Casper, WY 82605 E-mail: contact@HistoricWyoming.org
The Alliance for Historic Wyoming is a 501(c)(3) nonprofit organization
Board of Directors: Barbara Dobos ⊕ Sarah Egolf ⊕ Mary Humstone ⊕ Katherine Longfield ⊕ Jason Marsden ⊕ Tom Rea ⊕ Misty Stoll ⊕

From: info@gatewayeis.com
Sent: Friday, October 28, 2011 3:53 PM
To: Gateway BLM
Subject: A comment from gatewayeis.com

Name:
Chris Colson

Organization:
Ducks Unlimited

Mailing Address:
2533 North 26th Street

Mailing Address 2:

City:
Boise

State:
Idaho

Zip:
83702

Daytime Phone:
208-608-2441

E-mail:
ccolson@ducks.org

Confidential:
No

DEIS Location:

Comment:
To whom it may concern:

Ducks Unlimited, Inc (DU) is a private, 501(c) 3 non-profit organization that conserves, restores, and manages wetlands and associated habitats for North America's waterfowl, other wildlife, and people. Since its incorporation in 1937, DU has conserved over 11 million acres of habitat in the United States, Canada, and Mexico.

For over six decades Ducks Unlimited has maintained a singleness of purpose to conserve and restore wetland habitats. Our efforts benefit waterfowl and much more because of our landscape approach to habitat conservation. We work across political, geographic and ecological boundaries to achieve our mission.
Ducks Unlimited has more than 6,000 members in Idaho. DU is expressly interested in the potential impacts the Gateway West Transmission Line Project (Project) will impose upon Idaho

wetlands and migrating waterfowl. This letter represents DU's formal public comments specific to the Project's impacts within the state of Idaho.

Idaho has lost approximately 76% of its historical wetlands and recent studies have demonstrated that wetland loss is accelerating nationwide. While no annual standard surveys are conducted in Idaho, migratory waterfowl populations nationwide remain significantly lower than historic levels. Currently there are several species of waterfowl that remain below population goals established by the North American Waterfowl Management Plan. Degradation and loss of habitat are generally regarded as the cause for reduced populations. Idaho is a critically important spring migration stopover for migrating waterfowl and songbirds.

DU is generally opposed to any of the proposed routes and alternatives that are located within major valley floodplains and wetland features and prefer those that are situated in upland habitats. The EIS does not place adequate consideration to non-regulated natural resources. Wetland habitats have been evaluated from a regulatory standpoint, and as a vegetation community. However, federal and state laws do not recognize imperiled and/or rare habitat communities unless occupied by federally protected or recognized plants or animals that are associated with those respective habitats. DU argues that wetland habitats need to be considered as a limited and imperiled natural resource in the state of Idaho beyond the "no net loss" regulatory standard. And, from a regulatory standpoint, we expect the Bureau of Land Management (BLM) and Idaho Power Company (IPC) to honor Clean Water Act guidance that directs permittees to make all reasonable efforts to avoid and/or minimize wetland impacts.

In addition to the direct impact of the disturbance footprint, transmission lines pose additional indirect impacts to migratory waterfowl by providing advantageous hunting perches for predatory raptors and disrupting typically free low elevation fly areas above wetland habitats.

For the reasons discussed above, DU expects the BLM and IPC to strongly consider the following comments as they pertain to wetland and waterfowl habitat:

- DU is opposed to Segment 4-Proposed and it's crossing of the Bear River Valley. We are frustrated that no alternative is proposed for analysis. The Bear River Valley represents critical wetland and waterfowl habitat located within a major flyway. While we are encouraged with the existing route situated relatively well north of Bear River National Wildlife Refuge, a reasonable alternative with reduced wetland impact needs to be considered in the EIS.

- DU is strongly opposed to Segment 7-Proposed and 7-Alternative due to their proposed impacts and/or proximity to Marsh Creek and the Snake River and their associated wetland habitats. We propose Segment 7-H as a more suitable alternative.

- DU is strongly opposed to Segment 8A due to its proposed impacts to Billingsley Creek within the Hagerman Valley. The Hagerman Valley arguably provides Idaho's most critical migratory waterfowl habitat and some of the most contiguous and substantial wetland habitat within south-central Idaho.

- DU is strongly opposed to the proposed siting of Segment 8-Proposed where it is in close proximity to Clover Creek north of Bliss, Idaho. Floodplain habitat of Clover Creek upstream from Pioneer Reservoir is unnecessarily impacted and an upland alternative needs to be considered. Thousands of migratory Sandhill Cranes, among other migratory waterfowl, are regularly observed on the Clover Creek floodplain.

- DU is strongly opposed to Segment 9-Proposed for its proposed impacts to floodplain and groundwater spring wetland habitat associated with the confluence area of the Bruneau and Snake Rivers. We propose Segment 9E as a more suitable alternative.

The Project also directly impacts three current DU wetland restoration projects (Figure 1). The three projects are on the Bruneau River Ranch in Owyhee County (Figure 2), Six S Ranch (Figure 3) in Cassia County, and Spring Cove Ranch (Figure 4) in Gooding County. Collectively, the three projects have private, state, and federal restoration funding totaling nearly $1,000,000. Project partners include private individuals and foundations, Southern Idaho Land Trust, Idaho Fish and Game, Idaho Department of Environmental Quality, Natural Resources Conservation Service, and the U.S. Fish and Wildlife Service. DU is strongly opposed to direct impacts to these properties as substantial public funding has been invested to the restoration of wetland habitats on these properties totaling more than 500 acres.

- The Bruneau River Ranch (Figure 2) is located directly south of IPC's Turner Ranch. DU is concerned and frustrated that IPC and the BLM have proposed a route (Segment 9-Proposed) that impacts a neighbor of an IPC property as opposed to maintaining their project impacts on their existing properties. The Bruneau River Ranch is currently enrolled in the Natural Resources Conservation Service's Wetland Reserve Program and a conservation easement on the ranch is expected to close before the end of the year.

- Spring Cove Ranch (Figure 4) already has an existing IPC right-of-way on the property. The landowner is concerned that contesting the existing siting of the proposed line (Segment 8-Propsed) may only result in realignment onto a neighbor's property. DU proposes consideration of an alternative north of the existing proposed route out of the Clover Creek valley on BLM-owned upland lands.

- Concerning the Six S Ranch (Figure 3), DU met with IPC engineers on behalf of the ranch owners to discuss realignment of the proposed routes (Segments 7-Proposed and 7-Alternatives 7-D and 7-F) through the ranch. The owners are willing to have the line cross the property, but they are opposed to the existing location. Realignment was proposed and generally accepted by IPC with the exception of any necessary micrositing. The realignment agreed upon by IPC is presented in Figure 5. DU is opposed to the current location of the route and supports the realignment presented in Figure 5.

Please feel free to contact me directly with any questions or requests for further information. I look forward to our comments being addressed.

From: jmclain@blm.gov
Sent: Tuesday, October 04, 2011 12:11 PM
To: blm@gwcomment.com
Subject: Fw: comments on DEIS
Attachments: GEAS letter re_Gateway West DEIS.pdf

----- Forwarded by Joy Mclain/WYSO/WY/BLM/DOI on 10/04/2011 01:11 PM -----

American Kestrel <amke204@gmail.com>
09/30/2011 03:20 PM

To Gateway_West_WYMail@blm.gov
cc
Subject comments on DEIS

Hello
Please see the attached comments from the Golden Eagle Audubon Society.

Thank you.(See attached file: GEAS letter re_Gateway West DEIS.pdf)

Project Manager
Bureau of Land Management
Gateway West Transmission Line Project
P.O. Box 20879
Cheyenne, WY 82003

To Whom It May Concern:

On behalf of the membership of the Golden Eagle Audubon Society, an organization based in southwest Idaho representing 1500 members and advocating for the appreciation and conservation of birds and other species, we are writing to comment on the draft EIS for the Gateway West Transmission Line Project. Our comments are focused on the construction of transmission lines within the Morley Nelson Snake River Birds of Prey National Conservation Area (NCA).

We encourage development of a plan for ***a single*** new Gateway West Transmission Line that runs along ***route 9D*** (as proposed by the Owyhee Citizen's Task Force). We oppose construction of 2 new lines within NCA that will lead to increased habitat fragmentation and invasion of exotic species. We also oppose the other alternative routes for lines crossing the Snake River Canyon because they will increase hazards for avian species and diminish the beauty of one of Idaho's most famous natural areas.

The Bureau of Land Management manages the NCA to "conserve, protect and enhance raptor populations and habitats" (Public law 103-64). This special designation of the NCA was made because the Snake River Canyon supports a high density of nesting raptors, such as Prairie Falcons and Golden Eagles. High raptor nesting density has been shown to be related to high concentrations of prey, specifically Piute Ground Squirrels and Black-tailed Jackrabbits that depend on sage-steppe habitat. Construction of multiple lines through the NCA will promote habitat fragmentation and further invasion of exotic species, like Cheatgrass, that can have detrimental effects on the sage-steppe ecosystem, including small mammals that are an important prey base for raptors. Therefore, we do not support plans to develop new transmission lines and roads within the NCA.

Transmission towers may provide areas for perching for raptor species; however, vertical structures and increased raptor perches may deter Sage-Grouse activity. Further, many of the alternative routes for line crossings at the Snake River Canyon (e.g., crossings near Halverson Lakes and the Mouth of Sinker Creek) pose increased collision risk for flying raptors. Alternative route 9D minimizes habitat degradation because it follows an existing transmission line and the line will cross the Snake River Canyon at its narrowest point, reducing collision risk.

We feel it is important to convey our membership's interest in preserving the regionally significant habitats for the benefit of the widest suite of native birds and public interest. Thank you for the opportunity to comment on the draft EIS for Gateway West Transmission Line.

Sincerely,
Pam Conley, President
Golden Eagle Audubon Society
PO Box 8261
Boise, ID 83707

From: jmclain@blm.gov
Sent: Tuesday, October 25, 2011 9:22 AM
To: blm@gwcomment.com
Subject: Fw: Gateway West DEIS Comments
Attachments: HawkWatch GWDEIS Comments.doc

----- Forwarded by Joy Mclain/WYSO/WY/BLM/DOI on 10/25/2011 10:22 AM -----

"Steve Slater" <sslater@hawkwatch.org> 10/25/2011 09:48 AM

To <gateway_west_wymail@blm.gov>
cc
Subject Gateway West DEIS Comments

Please see the attached for HawkWatch International's comments on the Gateway West Draft Environmental Impact Statement.

Steven J. Slater, Ph.D.
Conservation Director
HawkWatch International
2240 South 900 East,
Salt Lake City, UT 84106-2327
Office: (801) 484-6808 Ext. 108
Cell: (801) 608-5827
Fax: (801) 484-6810
Conserving Raptors and Our Shared Environment (See attached file: HawkWatch GWDEIS Comments.doc)

HawkWatch International
1986 - 2011

Bureau of Land Management
Gateway West Project
PO Box 20879
Cheyenne, WY 82003.

To whom it may concern:

Thank you for the opportunity to provide comments on the draft EIS for the proposed Gateway West Transmission Project (GWDEIS). As a non-advocacy, science-based organization, we recognize the need for additional transmission line infrastructure to increase power reliability and to meet the transmission needs of various renewable energy projects near the proposed transmission line. However, we also stress that only through proper consideration of raptors and other wildlife can we reasonably reduce the potential risks that accompany all forms of development, and that associated with tall structures in particular. We hope that our comments are helpful to you as you begin the decision making process.

Regarding the entire project, we encourage the adoption of the single solid pole-structures for the transmission line towers to the maximum extent possible in order to avoid supporting increases in common raven (*Corvus corax*) populations. Lattice-type towers provide perching and nesting substrate for ravens, often increasing their population rapidly in areas with historically lower densities (Engel 1992, Steenhof 1993). This is problematic because ravens are known predators of greater sage-grouse (*Centrocercus urophasianus*; Coates 2007). Sage-grouse were petitioned for listing in 2010 and remain on the candidate list and raven depredation may become a concern for population stabilization or recovery. Power line structures may also unnaturally concentrate raptors (APLIC 2006) to the potential detriment of prey species. We commend the BLM for recognizing perching as a concern in the GWDEIS (see Table 2.1-6) and recommending deterrent devices on H-frame structures (GWDEIS TESWL-3), as research suggests they are effective tools in reducing perch use of such structures (Lammers and Collopy 2007, Slater and Smith 2010). However, we also suggest that greater use of single-pole support structures will also reduce raptor perching threats to BLM species of concern such as sage-grouse, pygmy rabbits (*Brachylagus idahoensis*), white-tailed prairie dog (*Cynomys leucurus*), ferruginous hawk (*Buteo regalis*), burrowing owl (*Athene cunicularia*), sage thrasher (*Oreoscoptes montanus*), loggerhead shrike (*Lanius ludovicianus*), Brewer's sparrow (*Spizella breweri*), and sage sparrow (*Amphispiza belli*), etc.

In addition to utilizing power structures to minimize risk of attracting ravens and raptors, it is critical that raptor nest surveys and protection measures (e.g., GWDEIS TESWL2 and 3.10-34, 35, and 36) are adhered to during construction and operation activities to avoid take of nests or disruption of breeding activity. Transmission lines and associated structures can also be

HawkWatch International
2240 S. 900 E. ● Salt Lake City, UT 84106 ● 801-484-6808 ● 800-726-HAWK ● Fax 801-484-6810
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WWW.HAWKWATCH.ORG

dangerous for birds due to risk of electrocution or collision. Regarding electrocution, we suggest that an Avian Protection Plan be developed for the transmission line in accordance with APLIC guidelines (http://www.aplic.org/).

Unfortunately, the DEIS does not give adequate consideration to the raptor collision risk associated with the project proponent's preferred route through Segment 4 that transects a known raptor migration ridgeline (See Figure 1 below). HawkWatch International has operated a fall migration count on Commissary Ridge for the past 10 years and has recorded an average passage of 3,665 raptors each fall and an average of 268 Golden Eagles (*Aquila chrysaetos*), 158 Bald Eagles (*Haliaeetus leucocephalus*), and 12 unknown eagles (Mika and Hawks 2011). Although the GWDEIS does acknowledge the existence of this HawkWatch site, it fails to address raptor migration passage volume, use of the entire north-south ridgeline for migration, or collision risk associated with the proposed line crossing the ridge perpendicular to this migration pathway (see GWDEIS 3.10-16). In contrast, the recently revised Kemmerer RMP (KRMP; BLM 2010) recognizes the migratory importance of the ridge (see KRMP page 3-60) and also acknowledges that powerlines are an ongoing issue for raptor conservation in the area (KRMP page 3-68). However, the GWDEIS fails to recognize these raptor-related topics as potential KRMP conformance issues (GWDEIS Table 2.2-1). Similarly, the list of issues affecting route decision for segment 4 in the GWDEIS did not include raptor migration issues (GWDEIS 2-61) despite the fact that we submitted comments of this nature during the scoping period and annually supply migration reports to the Kemmerer BLM, a primary supporter of this count site.

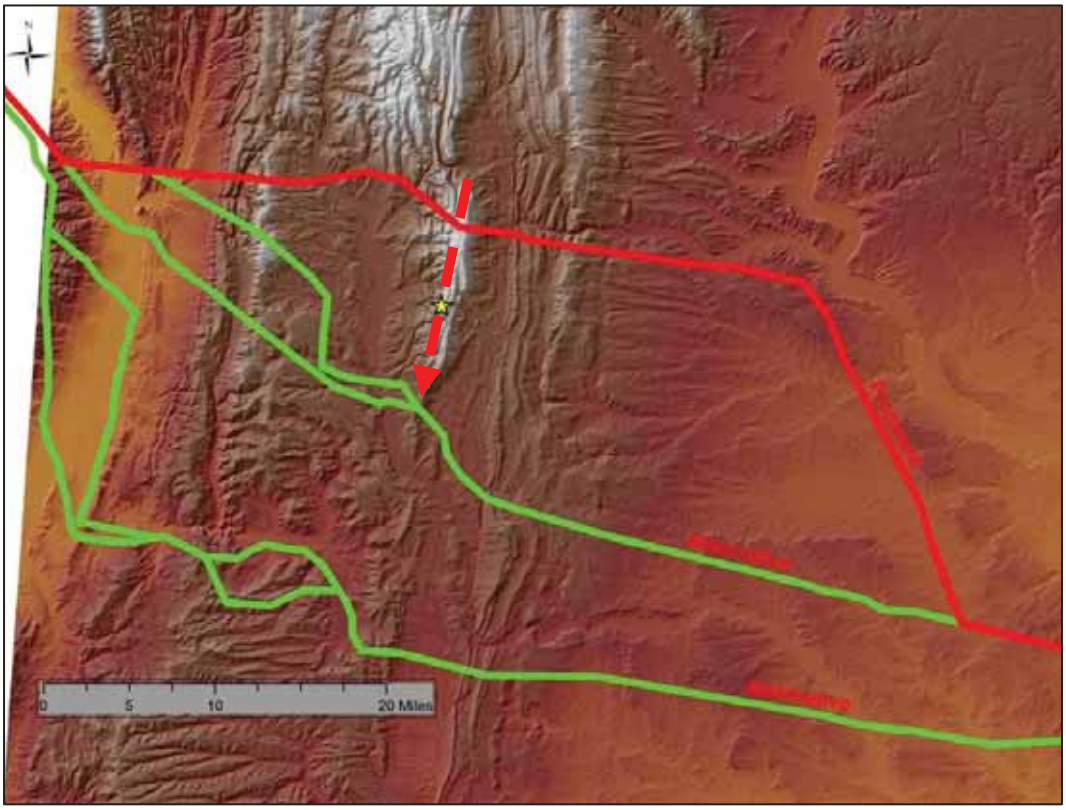

Figure 1. Proposed (red) and Alternative (green) routes along Segment 4 for the proposed Gateway West transmission project. HawkWatch International's long-term migration count site (star) is shown along the Commissary Ridge, Wyoming raptor migration corridor (arrow).

It should be noted that an earlier alternative route that passed directly through the HawkWatch count site has been abandoned; however, the risk to migrating raptors is not limited to the count site itself, but the entire north-south ridgeline of Commisary Ridge that is utilized as a migration corridor (see Figure 1). To the degree possible, the siting of the transmission line in Segment 4 should avoid transecting any high elevation north-south ridgelines to reduce the risk to migrating raptors that commonly use such features throughout the West (Goodrich and Smith 2008). For example, HawkWatch conducted an exploratory count during fall of 2001 near Prater Mountain in the Salt River Range (65 miles to the north-northeast of the Commissary Ridge count site) and counted 792 raptors, including 94 Golden Eagles and 24 Bald Eagles, during 118.9 hour of observation. Where such ridgelines cannot be completely avoided, bird diverters should be used to reduce collision potential. The GWDEIS suggests use of flight diverters (GWDEIS WILD-8), but primarily in relation to water crossings. This should be expanded to potential migration corridors as identified here. Additionally, pre- and post-construction surveys at such sites are recommended to determine collision risk and actual mortality and guide any necessary mitigation measures.

Both Bald and Golden Eagles are protected by the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle protection Act (BGEPA). The Bald Eagle is also a Wyoming BLM sensitive species. Additionally, The U.S. Fish and Wildlife Service (USFWS) has expressed a current “no net loss” goal for Golden Eagles, due to concern over the current population status (USFWS 2011). Given eagle use of Commisary Ridge as a migration corridor (i.e., average of 438 eagles per year), the proposed route for Segment 4 has the potential to result in unlawful take under the MBTA and BGEPA. An average of 39 Northern Goshawks (*Accipiter gentilis*) and 11 Peregrine Falcons (*Falco peregrinus*), both Wyoming BLM sensitive species, also pass through the site each fall. Given these concerns, we cannot agree with the conclusion of the GWDEIS that “The Gateway West Project would not have a measurable adverse effect on migratory bird populations or significant bird conservation sites” (GWDEIS 2-208 and 4-71) without considerable additional attention being given to the potential migratory raptor collision risk issue outlined here.

HawkWatch International (HWI) is a 501(c)3 non-profit science-based raptor conservation organization. We thank you for the opportunity to share our insights into the specific raptor-related issue associated with the Draft EIS. He hope these comments will be given due consideration during the final decision making process.

Sincerely,

Steven J. Slater, Ph.D.
Conservation Director
HawkWatch International, Inc.
801-484-6808 Ext 108
sslater@hawkwatch.org

Kylan W. Frye, M.E.M
Conservation Biologist
HawkWatch International, Inc.

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http://www.fws.gov/windenergy/docs/ECP_draft_guidance_2_10_final_clean_omb.pdf

From: Kerri Franklin
Sent: Thursday, October 13, 2011 11:02 AM
To: Gina Auriemma; Ara Swanson; Gateway BLM
Subject: FW: Gateway West DEIS sage-grouse concerns
Attachments: Gateway West DEIS sage-grouse concerns.pdf

Kerri Franklin | EnviroIssues

101 Stewart Street, Ste 1200 | Seattle 98101
206.269.5041 | www.enviroissues.com

From: George, Walter E [mailto:wgeorge@blm.gov]
Sent: Thursday, October 13, 2011 7:23 AM
To: Joe Iozzi
Cc: Kerri Franklin; Diane Adams
Subject: FW: Gateway West DEIS sage-grouse concerns

FYI

From: Lara Rozzell [mailto:lrozzell@idahoconservation.org]
Sent: Thursday, October 13, 2011 7:25 AM
To: Simpson, Donald A
Cc: George, Walter E; Ellis, Steven A
Subject: Gateway West DEIS sage-grouse concerns

Director Simpson,

Please find attached a letter reflecting our concerns with the sage-grouse information made available for public comment Gateway West DEIS. We will be following up with a hard copy of the letter. Please contact me or any of the signers of the letter with questions or a response.

Thank you,
Lara
--
Lara Rozzell
Public Lands Energy Fellow
Idaho Conservation League
PO Box 844, Boise, ID 83701
Office 208.345.6933 x 31 • cell 208.309.1644
http://www.idahoconservation.org • http://www.idahoconservation.org/blog
Twitter: iclnaturerocks
Facebook: /idahoconservationleague

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AUDUBON WYOMING * NATURAL RESOURCES DEFENSE COUNCIL
THE WILDERNESS SOCIETY * WESTERN RESOURCE ADVOCATES
ROCKY MOUNTAIN WILD * IDAHO CONSERVATION LEAGUE

October 13, 2011

Don Simpson, State Director
Bureau of Land Management
PO Box 1828
Cheyenne, WY 82003-1828

Via electronic delivery to dsimpson@blm.gov

Dear Mr. Simpson:

We are writing as a consortium of conservation and environmental non-profit groups interested in the protection of Greater Sage-Grouse. We represent members and supporters with a deep personal interest in sustaining our sagebrush landscapes, retaining the West's signature wildlife, and averting the economic consequences of a sage-grouse Endangered Species listing.

We are encouraged by the Bureau of Land Management's recent announcement of a regional strategy focusing on the conservation of sage-grouse and the protection of their habitat. As a designated priority pilot project, the Gateway West transmission line has the potential to be a key supporting element in the BLM's new strategy, bringing the most up-to-date science to route siting, impact analysis, and mitigation, thereby demonstrating BLM's commitment to adequate habitat protection and regulatory mechanisms. We note that route siting, sage-grouse impact analysis, and mitigation are inextricably tied together during project planning, as impact analysis and mitigation costs will drive routing changes to create a least-cost path.

We are actively engaged in preparing comments for the Gateway West Draft Environmental Impact Statement (DEIS), and find the sage-grouse analysis in the document is inadequate for evaluation and meaningful comment. Without a completed Habitat Equivalency Analysis (HEA) and quantification of indirect impacts, the public, the proponents, and the agency are unable to identify the best routing for the line and the mitigation needs. Without a completed density disturbance calculation (DDC), evaluation of compliance Wyoming Governor's Executive Order 2011-5 is not possible. We are also concerned about coherence with BLM's Idaho IM 2009-006, regarding incorporation of the *Conservation Plan for Greater Sage-Grouse in Idaho* and Local Working Group conservation plans.

The Draft EIS indicates that sage grouse impacts are a crucial component of the analysis and that mitigation is a necessary element for determining project approval. Yet, the draft does not share the information needed to allow the public, the proponents, or agency decision-makers to evaluate meaningfully the full range of impacts and the adequacy of mitigation. Under these circumstances, the agency should circulate a revised draft in the form of a Supplemental Environmental Impact Statement (SEIS), per 40 C.F.R. §1502.9. We formally request an SEIS including the fully completed HEA, quantification of indirect impacts, a compensatory mitigation plan with projected costs, and a DDC. Such an SEIS will allow the public, the proponents, and the agency to identify the best route, meaningfully evaluate sage-grouse impacts, evaluate compliance with Wyoming Executive Order 2011-5, and plan effective mitigation.

BLM's response to this request will influence our comments during the public comment period. We request direct meetings with BLM in Wyoming and Idaho to discuss approaches to providing complete information for analysis. Please contact me at lrozzell@idahoconservation.org or at (208) 345-6933 x 31 with questions or concerns, or contact any of the signers below.

Sincerely,

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signing for

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Wyoming Outdoor Council * Powder River Basin Resource Council

October 28, 2011

Project Manager
Gateway West Transmission Project EIS
Bureau of Land Management
P.O. Box 20879
Cheyenne, Wyoming 82003

Via U.S. Postal and email (Gateway_West_WYMail@blm.gov)

Re: Comments on Proposed Gateway West Transmission Line Project DEIS

Dear Mr. George:

The following comments are submitted on behalf of the undersigned groups (the Conservation Groups), summarizing our collective concerns and recommendations on the draft Environmental Impact Statement (DEIS) for the proposed Gateway West transmission project. These comments reflect our broad concerns from the conservation perspective and identify routes with the least amount of environmental impact.

The American West's natural resources are too precious and unique to sacrifice – in the long term to climate change or in the short term to energy development. The West has a long history of providing fossil fuel, complemented by the more recent discovery of significant sources of renewable energy, such as solar, wind and geothermal power. The vast, open landscapes also harbor diverse wildlife, irreplaceable cultural resources, and remarkable wildlands that have long defined our American heritage. As our nation struggles with ways to meet growing energy demands and the challenges of climate change, the ability to balance these will require thoughtful, comprehensive, and pro-active planning. We appreciate the outreach efforts to date and continue to champion the efforts to identify the most environmentally appropriate sites for clean energy projects and transmission lines.

While the remainder of the document addresses our collective concerns in greater detail, our primary recommendations are to urge the BLM and the proponents to:

- Disclose additional information on resources that could be impacted along the routes in a supplemental document for public review and comment, particularly for high-profile wildlife species such as Greater Sage-grouse and golden eagles;

- Recognizing the benefits of energy-efficiency and a sustainable energy economy and the costs associated with continuing coal generation, create a "statement of purpose and need" for the project that prioritizes agency statutory purpose and public interest
- Create clear criteria for the route selection process
- Include a full range of alternatives for project development, including the potential for the joint use of corridors by other project sponsors;
- Improve and expand opportunities for stakeholder involvement, which will be critical for minimizing impacts and building stakeholder confidence and support;
- Include a detailed Construction, Operation and Maintenance Plan;
- Provide comprehensive information and analysis on technologies that could be implemented to minimize impacts, such as burying lines;
- Prepare a comprehensive Cumulative Impacts Analysis assessing the additional projects and ongoing activities already planned or reasonably foreseeable for the affected area, including but not limited to additional transmission lines, energy development, and power generation projects – as well as other activities which could impact individual species, ecosystems, landscapes and other resources;
- Consider a full range of off-site mitigation strategies to improve conditions for wildlife and habitat, in addition to avoidance and on-site mitigation;
- Make all GIS spatial data developed as part of the EIS process available for public download on the BLM project website;
- Make all underlying information, reports and studies referenced in the DEIS available for viewing and download on the BLM project website; and
- Include a map depicting all existing, designated and proposed energy transmission corridors, supplemented by a description of the nature of the corridor, and the date and status of designation.

If an action alternative is chosen, the project's environmental impacts should be avoided to the greatest extent possible by siting in areas with low resource values and minimized and mitigated to the best degree possible, using best management practices, the best available technology, and innovative strategies for both on and off-site mitigation. The FEIS should develop a mitigation component that provides for no net loss in habitat for wildlife species.

In closing, we welcome the opportunity to meet with the Rapid Response Team as well as BLM state offices to share our expertise in transmission planning, wildlife habitat protection and restoration, and land management planning. Improving transmission infrastructure provides a unique opportunity to be forward-thinking in our approach, by selection of greener technologies and siting to preserve priceless landscapes and iconic wildlife species. However, we are sensitive to the reality that this proposed transmission line presents unique challenges, and thus we are all available should there be any questions or need for additional information. We recently learned of the BLM's intention to hold stakeholder siting resolution meetings and are very interested in being involved with these. Thank you for your consideration of our comments.

Respectfully submitted by:

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I. Energy and Climate Issues

Energy and climate issues are inextricably linked with the health of our communities and environment. Our nation's ongoing reliance on fossil fuels, coupled with the unprecedented threats brought about by climate change, threaten to dramatically alter ecosystems and available water supplies. On a daily basis, important wildlife habitats are lost as landscapes are modified in the process to extract and transport various forms of energy development throughout the American West.

To sustain our communities and the environment on which we are all dependent, the nation must build a portfolio that is less reliant on fossil fuels. To do this, we must eliminate energy waste; moderate demand through energy efficiency, conservation, and demand-side management practices; and support the rapid development of clean, renewable energy technologies that are appropriately sited and designed.

Our nation's growing energy demands requires improvements to an aging transmission infrastructure. This will require upgrades to existing lines and construction of new transmission lines. Transmission development can be detrimental to sensitive wildlife and cultural resource sites, requiring thoughtful planning and careful siting to minimize conflicts. Thorough review under the National Environmental Policy Act of 1969 (NEPA) is an essential part of determining which of the many proposed utility-scale projects should be permitted to go forward on public lands. Close scrutiny is especially warranted when new proposed lines would primarily carry power generated by fossil fuels.

Environmental and conservation groups across the West are very much aware of the simultaneous need to reduce the threats to climate change while avoiding and minimizing impacts from renewable energy generation and transmission. We also recognize that each project is different and will need to be reviewed on its own merits, with aspects of some projects not being acceptable within the larger environmental community.

One of those general conditions of support for transmission lines will be that a new line will not facilitate any new generation of electricity from coal fired plants. New generation is defined here to mean that no new, or previously planned, coal plants are built as a result of any proposed new transmission. We strongly prefer that any new lines facilitate only renewable energy generation but understand the FERC open access constraints. Given those constraints, however, we expect for BLM to scrutinize the probability that GWW will facilitate only renewable energy generation, and to explicitly address the possibility of facilitating new generation from coal plants. We expect for BLM and PacifiCorp to provide as much assurance as it can that the line will facilitate only renewables (see Recommendation in Section II). The statement in the DEIS that as of June, 2011 the only subscribers to the line were from renewable sources is a good example of the type of assurances we seek. Given the immense importance of no new coal, one or more of the groups supporting these comments reserve our responsibility to oppose the entire line or specific segments if it becomes apparent that new generation from coal could be enabled by the line.

The following principles should guide federal decision-making on this and other transmission proposals. Our comments reflect these principles of responsible planning:

- Strong local, state, national, and regional commitments. By adopting wiser energy conservation practices to improve efficiency, we increase existing transmission capacity and minimize impacts.
- Local generation of renewable energy**.** Local generation increases self-sufficiency, reduces transmission needs, creates local jobs, and can help make the grid more resilient. Many large load centers are near excellent sources of renewable energy, including the desert southwest. While local generation alone will not meet greenhouse gas reduction goals, it plays a critical role in reducing emissions.
- Transmission efficiency. Transmission efficiency includes using existing corridors and lines more effectively – removing bottlenecks, upgrading wires and connections, adding "smart grid" features that increase grid capacity and flexibility, and eliminating redundancy. Operational efficiencies such as Balancing Authority Area coordination should also be considered. Efforts to improve efficiency of existing technology should be supported.
- Transmission planning. Transmission planning should include early analysis of environmental and cultural resource conflicts, thus improving ability to avoid these. Planning should also include consideration of proactive ways to address anticipated growth and ways to reduce of carbon emissions. The latter includes improving the ability for consumers to use their electric cars, efficient grid operation and energy storage. Planning a modern grid should take account of the cumulative impacts and life-cycle GHGs of all connected and complementary actions, based on the best available science and peer-reviewed literature.
- Right-sized growth**.** Transmission resources need to make the best use of existing corridors and new developments should be coordinated and scalable so that fewer corridors will be needed in the future. An example of this would be constructing a tower to which an additional circuit could later be added, or to which a higher voltage rating could be obtained through reconductoring at a later time. Efficiently scaling transmission also reduces carbon emissions by reducing line losses.
- New stakeholders, shared vision. Transmission policy is no longer the exclusive province of utilities and regulatory commissions – conservationists and other interests are actively involved in the dialogue and policy process. Conservationists agree that it is possible to build responsibly-sited projects faster, better, and with less expense, all while minimizing harm to the environment (Dart et al. 2011). Improving our transmission infrastructure provides a unique opportunity to be forward-thinking in our approach, by selection of greener technologies and siting to preserve priceless landscapes and iconic wildlife species.

II. Related Energy Generation

Several aspects of the proposed Gateway West line raise questions regarding the degree to which this project would contribute to a greener grid. We support the regional and national consensus that future grid upgrades should aspire to and be conditioned on furthering progress towards a clean energy economy that takes environmental and climate impacts into account.

- Redundancy, reliability and grid upgrades are among the leading justifications for Gateway West, rather than emphasizing a cleaner electricity production and delivery system.
- Analysis should consider the extent to which the region's reliability goals can be achieved through other means than this proposed transmission project.
- The source of power is not specified beyond "thermal and renewable sources," leaving the door open to new thermal plants burning fossil fuels and leaving unanswered important questions as to the specifics of any new or expanded generation capacity, whether fossil fuel or renewable. Analysis should include greater information on source of power, preferably with an emphasis on renewable energy sources.
- PacifiCorp's current proposed Integrated Resource Plan for Utah lacks a strong commitment to greening the grid and fails to adequately address climate change.
- Gateway West is proposed as part of PacifiCorp's larger Gateway Transmission Expansion program, which includes Gateway Central (already built) and Gateway South (proposed, DEIS pending). Accordingly, the DEIS needs to analyze the inter-relationship between these connected actions.
- In light of the fact that other transmission lines exist or are proposed along much of the proposed route, close scrutiny is needed on how impacts can be avoided and mitigated in the event multiple projects are ultimately approved and constructed. This includes analysis of:
    - the extent to which it may be possible for the same vertical structures to serve more than one project along all of the parallel routes or specific segments where the impacts of parallel lines would be most significant, and
    - in the alternative, if separate vertical structures are utilized, options for reducing the spacing between the lines for sensitive segments.

- ***Recommendation:*** Transmission and generation are inextricably linked. As an AC line, power from additional, unspecified projects can be added to the proposed Gateway West line. Therefore, analysis should include information on source of power, preferably with an emphasis on renewable energy sources. To provide increased confidence that the line will principally carry renewable energy, PacifiCorp and BLM should provide continuous, transparent updates on potential subscribers to the line and explicit statements of generation intent for the line within any revisions of this EIS, IRPs, and state rate cases while acknowledging open access rules. The FEIS needs to also include discussion on how impacts can be avoided and mitigated in the event multiple transmission projects are ultimately approved and constructed within a given area.

III. Purpose and Need for the Project

The purpose and need section in the FEIS must prioritize the agency's statutory mission and public interest. We are unaware of a precedent for creating a "Proponents Purpose and Need" section. *NPCA v. BLM* 586 F.3d 735 (9th Cir. 2009) states that the court's task is to "determine whether the BLM's purpose and need statement properly states the BLM's purpose and need, against the background of a private need, in a manner broad enough to allow consideration of a reasonable range of alternatives."

While we realize energy demand and utility concerns are relevant, the BLM may not substitute the proponent's purpose for its own.

When selecting alternatives, an agency may *consider* an applicant's desires, but is not bound or limited by them. It is not appropriate for an agency to rely on the "selfserving statements of the project applicants." *Southern Utah Wilderness Alliance v. Norton*, 237 F. Supp. 2d 48, 53 (D.D.C. 2002). Instead, BLM as the action agency here must "to the fullest extent possible . . . study, develop and describe appropriate alternatives to recommended courses of action in any proposal which includes unresolved conflicts concerning alternative uses of available resources." *Id*. at 54 (citing 42 U.S.C. § 4332(2)(E)). Moreover, "[o]ther factors [other than the applicant's desires] to be developed during the scoping process—comments received from the public, other government agencies and institutions, and development of the agency's own environmental data—should certainly be incorporated into the decision of which alternatives to seriously evaluate in the EIS." CEQ, Guidance Regarding NEPA Regulations, 48 Fed. Reg. 34,263, 34,267 (July 28, 1983).

As courts have cautioned, "One obvious way for an agency to slip past the structures of NEPA is to contrive a purpose so slender as to define competing 'reasonable alternatives' out of consideration (and even out of existence.)" *Davis v. Mineta*, 302 F.3d 1104, 1119 (10th Cir. 2002) (quoting *Simmons v. United States Army Corps of Eng'rs*, 120 F.3d 664, 669 (7th Cir. 1997). Alternatives analysis is "the heart" of NEPA analysis process.

The "Proponents Purpose and Need" section appears to box the BLM into approving construction of the project based on the recommendations of unrelated federal agencies and on outdated energy projections, and appears designed to avert discussion of whether this project is needed for the public interest, or whether alternatives such as demand-side management and local generation could replace the large-scale transmission approach. If the FEIS ignores this alternative, it may not comprise an adequate hard look. "The existence of a viable but unexamined alternative renders an environmental impact statement inadequate." *Idaho Conservation League v. Mumma*, 956 F.2d 1508, 1519 (9th Cir. 1992), *quoting Citizens for a Better Henderson v. Hodel,* 768 F.2d 1051, 1057 (9th Cir. 1985). And under NEPA, the EIS may even have to look at alternatives over which the applicant has no control. *NRDC v. Morton*, 458 F.2d 827, 835 (D.C. Cir. 1972); *NWF v. NMFS*, 235 F. Supp. 2d 1143 (W.D. Wash. 2002); *Van Abbema v. Fornell*, 807 F.2d 633, 638 (7th Cir. 1986).

The Purpose and Need statement in the DEIS is also problematic because it is based on the 2009 IRPs. Both proponents have newer IRPs reflecting the decreased need for Gateway West, as originally configured. The "Proponents Purpose and Need" section furthermore misstates a key element of the PUC and IRP process in Section 1.3.2. Neither "acknowledgment," used by several of the Commissions that regulate PacifiCorp or "acceptance" used by the Idaho Commission, connotes approval of the resource acquisition plan. For example, in Utah, acknowledgment indicates that the Company generally adhered with the Utah Commission's 1992 Order on Standards and Guidelines, not approval of the chosen resource acquisition plan. In Idaho, PUC acceptance reflects acceptance of the process used to create the IRP, not necessarily the results. Thus, PUC "acknowledgment" or

"acceptance" does not signal agreement of an appropriate balance of demand-side measures, additional generation, and transmission.

Section 1.3.3.1 of the "Proponents Purpose and Need" statement references DOE's National Electric Transmission Congestion Study. In *Wilderness Society v. U.S. Department of Energy*, the U.S. Court of Appeals for the Ninth Circuit found that the DOE's congestion study was so flawed as to be illegal and in violation of the intent of the Energy Policy Act of 2005 (EPAct). The court held that DOE failed to consult with the affected States in undertaking the Congestion Study as required by § 824p(a)(1) of EPAct. As discussed in the decision, the failure to consult caused the study to fail to consider important issues, such as the definitions of "congestion" and "constraint," the need to accommodate state laws and policies such as renewable energy standards, identifying areas subject to congestion and constraint, and the need to conduct an analysis of environmental consequences. As a result, BLM should not take the findings of the DOE's Congestion Study into account when determining where transmission is needed. Rather, the agency should be considering other factors that affect the need for new transmission (such as renewable energy standards, efficiency and demand management initiatives, and environmental impacts). The question of whether demand-side measures and additional local generation could avert the need for large transmission projects is still open for analysis.

While Gateway West has been proposed in order to relieve operating limitations, increase capacity, and improve reliability, information to date inadequately addresses the sources of power to be carried on the line. In fact, Section 2.1.4 states "Due to the uncertain economic conditions, some of the potential customers for Gateway West have cancelled or deferred project development plans."

Rather than attempt to rely on the proponents' purpose and need, the BLM must develop its own such statement. Its purpose and need statement should reflect the public interest in a cleaner energy economy, and potential alternative means of achieving that goal.

The BLM's Purpose and Need must reflect the June, 2011 report titled "A Policy Framework for the 21st Century Grid: Enabling Our Secure Energy Future." This recent report published by the White House outlines policy recommendations that build upon the Energy Independence and Security Act of 2007 and the Obama Administration's smart grid investments to foster long-term investment, job growth, innovation, and help consumers save money. A 21st century electric system is essential to America's ability to lead the world and create jobs in the clean-energy economy of the future. The Administration has made unprecedented investments in clean-energy technologies and grid modernization.

More recent policy statements by the White House and the Departments of Energy and Interior have made these same points. "To compete in the global economy, we need a modern electricity grid," according to a statement by Energy Secretary Steven Chu reported on October 5, 2011. "An upgraded electricity grid will give consumers choices while promoting energy savings, increasing energy efficiency and fostering the growth of renewable energy resources."

At the Department of Energy, the New Energy Frontier recognizes the need to "move our nation toward a clean-energy economy" that prioritizes "environmentally appropriate renewable-energy projects[.][1]"

- ***Recommendations***: BLM should create a purpose and need analysis that clearly reflects public policy goals and the public interest, rather than relying on the proponents' more narrow purpose and need. Where it is appropriate to reflect the proponents' purpose and needs, it should be with updated information from the most recently filed IRPs[2].

  Other analysis options addressing electricity demands should be available, including conservation, energy efficiency, and the construction of renewable and more environmentally-sensitive energy projects closer to the population demand centers. Beyond generic statements that Gateway West may include some undefined renewable energy component, the FEIS needs to rigorously analyze (1) whether this project will facilitate access to clean domestic energy and reduce greenhouse gas emissions, and (2) the extent to which a combination of upgrades to existing lines could meet the purpose and need.

  The BLM's purpose and need statement should recognize policies and laws fostering development of an environmentally responsible modern grid taking climate change concerns into account. Analysis should address how the proposal could affect the ability to implement policies, orders and laws that mandate or encourage the development of renewable energy sources and associated transmission. The Energy Policy Act of 2005 requires the Department of the Interior to seek to approve at least 10,000 MW of non-hydropower renewable energy on public lands by 2015. The White House has established a Federal policy goal of producing 10% of the nation's electricity from renewable resources by 2010 and 25% by 2025.

IV. A Full Range of Alternatives

The FEIS must explain why the agency is identifying preferred alternatives and what criteria it will use to decide among the proposed routes. To the extent possible, alternatives should identify the potential to make the most efficient use of preferred corridors and Right-of-Ways. Alternatives should minimize surface disturbance by siting on already mechanically disturbed lands, brownfields, and existing linear features such as rail lines, etc. As there are numerous transmission proposals intended to serve the same electricity markets, the analysis should include the possibility of an alternative that permits shared ROW usage.

Transmission infrastructure is likely to be located in these corridors for fifty years or longer. Today's planning and environmental review needs to consider how to address potential future needs, such as

[1] See http://www.doi.gov/whatwedo/energy/index.cfm
[2] PacifiCorp's most current IRP was filed March 31, 2011 in the states with jurisdiction over Pacific. The IRP is currently undergoing regulatory review.

expanding electricity demand due to population growth and the need to mitigate of climate change impacts. Siting and technology should be considered proactively.

Finally, the environmentally-preferred alternative should take into consideration all the environmental and climate impacts that could stem from this proposal and the overall configuration of the modern regional grid. Thus, the environmentally-preferred alternative should minimize impacts from both the line and the life-cycle impacts of the energy development and power generation associated with the line.

- ***Recommendation:*** The FEIS should include a full range of alternatives and its criteria for deciding among routes. The range of alternatives should consider ways to minimize disturbance through joint use of corridors, discussion on how to address potential future energy needs, and a comprehensive environmentally preferred alternative based on the cumulative impacts of this project and related actions or decisions (including energy generation).

V. Project Design and the Mitigation Hierarchy

Generation and transmission of appropriately sited and designed renewable energy solutions are needed for transitioning away from the dirty sources of energy that are altering our climate and threatening wildlands, wildlife, water, public health, future prosperity, and our national security. **It also is important that the development of those energy solutions do not unnecessarily damage the public's natural resources.** The BLM's Habitat Mitigation Policy, codified at 43 C.F.R. § 1508.20, lists habitat mitigation actions in descending order of preference: avoidance, minimization, and compensation.

If an action alternative is chosen, the project's environmental impacts should be avoided to the greatest extent possible by siting in areas with low resource values and minimized and mitigated to the best degree possible, using best management practices, the best available technology, and innovative strategies for both on and off-site mitigation. The FEIS should develop a mitigation component that provides for no net loss in habitat for wildlife species.

A. <u>Avoiding Impacts</u>

1. Transmission Planning

One of the first and most important steps to avoid impacts to sensitive resources is to plan potential transmission corridors so that they are developed within existing corridors, ROWs, brownfields and other degraded lands, and other areas with co-locating opportunities.

Equally important is planning to avoid lands within the categories listed below that are either statutorily protected from development such as transmission and those that should otherwise be avoided, such as designated Greater Sage-grouse core areas. This includes:

- National Park Service lands;

- National Wildlife Refuges;
- National Monuments;
- Wilderness Areas;
- Wilderness Study Areas (WSA);
- National Conservation Areas;
- Other lands within BLM's National Landscape Conservation System (NLCS), such as Outstanding Natural Areas;
- National Historic and National Scenic Trails;
- National Recreation Areas;
- National Wild, Scenic, and Recreational Rivers, study rivers and segments, and eligible rivers and segments;
- U.S. Forest Service Roadless Areas;
- Areas of Critical Environmental Concern (depending on the extent to which the impacts of a line could compromise the resources which the ACEC was designated to protect);
- State mapped wetlands;
- Habitat areas for candidate or listed wildlife species;
- State mapped crucial big game winter ranges/severe winter ranges;
- State mapped wildlife corridors;
- Critical habitat (birds, plants, freshwater fish, mammals, reptiles, amphibians, insects), including critical core and linkage areas;
- Important Bird Areas (IBA);
- Special Recreation Management Areas (depending on the extent to which the impacts of a line could compromise the resources which the SRMA was designated to protect);
- Citizen-proposed wilderness areas;
- Other lands with wilderness characteristics;
- Research Natural Areas;
- Natural Resources Conservation Service Easements;
- State Parks;
- State Forests;
- State Wildlife Areas;
- Traditional Cultural Properties; and
- Sacred Sites.

Throughout the West, important wildlife movement corridors, landscape connections, and crucial habitats are threatened by multiple forms of development on a given landscape. These corridors and connections are crucial to the current and long-term viability of game and nongame wildlife, especially as they provide adaptation options in the face of a changing climate. Depending on the wildlife species and landscape, transmission lines can contribute to loss, fragmentation, and diminished resiliency of these habitats. The recent publication of a 10-year regional transmission plan by the Western Electricity Coordinating Council incorporates, for the first time, environmental data into transmission planning (Western Electricity Coordinating Council 2011). Many of the geospatial datasets referenced above are suggested as data sources that could help developers identify early on where they may encounter environmental resource conflicts.

2. Transmission Siting

Avoiding sensitive resources can also be achieved during the siting of transmission line Right-of-Ways (ROW) and individual towers within the proposed corridors. This approach to avoidance will be particularly important when transmission line ROWs are planned near habitat of Greater Sage-grouse and near important habitat for other species of concern. The sage-grouse is a candidate species within the federal Endangered Species Act (ESA), and the focus of an intensive BLM effort to create a National Greater Sage-Grouse Planning Strategy. Consequently, it is particularly important to avoid additional impacts on habitat for this species, as is discussed in greater detail in the sage-grouse section (p.31).

Avoiding impacts during siting will require extensive geospatial data on the location of the protected and sensitive lands and species, with efforts currently underway to compile this as a tool for planners (Western Electricity Coordinating Council 2011). The quality and availability of these data will vary considerably across the extent of the proposed line, with a majority focused on public lands. The absence of data from private lands does not necessarily indicate the absence of sensitive resources. Conservation easements are one tool for identifying specific development restraints on sensitive wildlife habitats. However, on-the-ground surveys consistent with guidelines provided by the USFWS or state wildlife agencies will be required before ROWs are finalized and construction begins.

Specific information about the sensitivity of endangered, threatened, and candidate wildlife species to disturbance will also be required to establish effective buffer zones around the most sensitive habitats to minimize direct, and indirect impacts. For example, data from peer-reviewed research on oil and gas development on grouse and transmission development on Lesser Prairie-chickens (closely related to sage-grouse) all indicate that tall structures, habitat fragmentation, and human disturbance cause direct and indirect impacts to nearby leks and populations. Consequently, established guidelines and best management practices principally developed for oil and gas threats are a valuable tool for proactively reducing transmission-related impacts to grouse species. The best way to reduce direct or indirect impacts, however, is to avoid critical habitat by siting the ROW away from leks and important habitat. It will be important to use the latest science in developing sage-grouse avoidance for the project. The *Studies in Avian Biology* (Knick and Connelly 2011)\ monograph published this year includes the following findings:

- Conservation of sagebrush within 5 km of leks has been recommended to maintain the most locations used for nesting and early brood-rearing by nonmigratory populations, whereas 18-km radii have been recommended for migratory populations (Wakkinen et al. 1992, Connelly et al. 2000a, Holloran and Anderson 2005). Characteristics at 54-km radii may influence seasonal movements and also incorporate habitats used outside the breeding season (Swenson et al. 1987, Leonard et al. 2000). *See* Ch.18, p.11.
- Power line poles along transmission corridors provide nest and perching opportunities for Common Ravens (*Corvus corax*), American Crows (*C. americanus*), and raptors (Reinert 1984, Knight and Kawashima 1993, Steenhof et al. 1993, Lammers and Collopy 2007). Ravens are primary predators on sage-grouse and other prairie grouse nests (Coates et al. 2008, Manzer and Hannon 2005) and can travel >10 km from these locations (Boarman and Heinrich 1999). *See* Ch.13, p.54.

- Lek count trends were negatively related to proximity to the closest communications tower and to the number of towers within 18 km. Research has suggested that sage-grouse avoid transmission lines in general and during the breeding season (Ellis 1985, Braun 1998), and Lesser Prairie-Chickens also avoid them in general and when nesting (Hagen 2003, Pitman et al. 2005). *See* Ch.17, p.27.

The BLM's analysis of sage-grouse impacts and calculated costs of off-site mitigation are likely to affect both routing and micrositing of the transmission lines. As stated elsewhere, these analyses must be completed and made available for public comment … "an agency must disclose the technical studies and data upon which it bases a ruling" *American Radio Relay League, Inc. v. FCC*, 524 F.3d227 (DC Cir. 2008).

- ***Recommendations:*** Transmission planning should prioritize existing corridors, ROWs, brownfields or degraded lands, and other areas with co-locating opportunities. Early review of geospatial datasets is important to predict and avoid environmental resource conflict, as transmission lines can contribute to loss, fragmentation, and diminished resiliency of vital habitats.

  On-the-ground surveys consistent with guidelines provided by the USFWS or state wildlife agencies should be required before ROWs are finalized and construction begins. The best available scientific data should be used to determine effective buffer zones around the most sensitive habitats to minimize direct and indirect impacts. We recommend sage-grouse conservation begins with a minimum 5 mile buffer around leks, to encompass nesting and early brood rearing activities and to maintain a distance from newly introduced predator perches. Finally, the Idaho Department of Fish and Game's latest modeling of sage-grouse habitat focusing on winter habitat and seasonal movement corridors, completed by the Natural Heritage Program, should be included in analyses.

B. <u>Minimizing Impacts</u>

1. Environmental Protective Measures

We commend the BLM and the proponent on their early efforts to develop Environmental Protective Measures (EPM) and additional mitigation measures. However, as with other items in the DEIS, the information provided is inadequate for analysis and public comment. BLM Manual Section 6840 gives the following instructions for special status species mitigation measures:

> "Address the anticipated effectiveness of these mitigation measures in reducing or avoiding adverse impacts in your analysis. Describe residual effects of any adverse impacts that remain after mitigation measures have been applied."

The DEIS contains lists of potential mitigation measures in Chapter 2 and in Appendix C, but does not analyze anticipated effectiveness and does not make clear which mitigation measures are to be required. Page 2-142 of the DEIS states "It is anticipated that as the NEPA process proceeds, additional coordination between the Proponents and the BLM and cooperating agencies will result in

alterations to the EPMs and mitigation measures, ultimately resulting in many mutually agreed-to measures that can be applied Project-wide to further protect sensitive resources." The EPMs and mitigation measures adopted are crucial to the analysis of affected resources – without knowledge of the mitigation measures to be applied, conclusions about impacts to species cannot be drawn and the public cannot meaningfully comment.

We are also concerned that the "mutually agreed-to" statement may be unlawfully conceding BLM's authority to require mitigation measures. Regarding rights-of-way over the public lands, as at issue here, Section 505 of FLPMA requires that BLM must avoid and minimize damage to fish and wildlife habitat, and that BLM retains authority to impose conditions necessary to achieve this purpose –or deny the requested right-of-way if it cannot do so consistent with Section 505 and other requirements of law.

Specifically, FLPMA Section 505 provides that:

> Each right-of-way shall contain…
> (a) terms and conditions which will (i) carry out the purposes of this Act and rules and regulations issued thereunder; (ii) minimize damage to scenic and esthetic values and fish and wildlife habitat and otherwise protect the environment; (iii) require compliance with applicable air and water quality standards established by or pursuant to applicable Federal or State law; and (iv) require compliance with State standards for public health and safety, environmental protection, and siting, construction, operation, and maintenance of or for rights-of-way for similar purposes if those standards are more stringent than applicable Federal standards; and
>
> (b) such terms and conditions as the Secretary concerned deems necessary to (i) protect Federal property and economic interests; (ii) manage efficiently the lands which are subject to the right-of-way or adjacent thereto and protect the other lawful users of the lands adjacent to or traversed by such right-of-way; (iii) protect lives and property; (iv) protect the interests of individuals living in the general area traversed by the right-of-way who rely on the fish, wildlife, and other biotic resources of the area for subsistence purposes; (v) require location of the right-of-way along a route that will cause least damage to the environment, taking into consideration feasibility and other relevant factors; and (vi) otherwise protect the public interest in the lands traversed by the right-of-way or adjacent thereto. 43 U.S.C. § 1765.

We are concerned with TESWL-16, which provides for requests for exceptions to the stipulations for sage-grouse and other species. The reference to WILD-1 for "established federal process" leads to a statement listing factors to be considered, but no specific guidance for granting exceptions. Exceptions to the stipulations established through the NEPA process must be disclosed and an opportunity for public comment provided.

We recommend that mitigation measures be applied uniformly across the project, rather than applied within a single jurisdiction. For instance, mitigation measures TESWL-22 and -23, referenced in Table 2.7-1, should be applied project-wide rather than only in the Kemmerer Field Office.

2. Reclamation and Adaptive Management

The introduction of aggressive fauna and flora invasive species are often linked to human disturbances, such as new roads and construction of facilities associated with the proposed transmission line. Page 3.10-43 states "The Reclamation, Revegetation, and Weed Management Plan would be in place, so noxious weed spread would be minimized and would not be expected to negatively impact wildlife habitat in the analysis area." The mere existence of a plan does not minimize impacts or create revegetated lands. The FEIS should include an aggressive weed management plan and reclamation plan, followed by required monitoring to determine effectiveness. The FEIS should also include an adaptive management plan to ensure that invasive species concerns or reclamation challenges are fully and promptly addressed. A plan that looks sound on paper but is not adequately implemented or monitored would not comply with governing law, and would fall short of all stakeholders' expectation that this project avoid, minimize and mitigate environmental impacts.

Ensuring reclamation of disturbed habitat with native species will require plan informed by the best available science as well as a rigorous inspection and monitoring program to achieve goals and objectives in the short-, medium- and long-term. Reclamation success correlates closely with adequate funding and effective inspection and enforcement efforts to rectify any initial failures.

Reclamation is challenging over much of the proposed route, which is characterized by arid conditions, thin soils and short growing seasons. In this sagebrush-steppe community, in addition to the slow regeneration of sagebrush, the biggest threat is the invasion of the highly aggressive cheatgrass (*Bromus tectorum*)[3]. We strongly encourage consultation with other agencies having expertise in reclamation to employ the practices that have proven to have the best success in preventing quality habitat loss, having reduced impacts to existing vegetation using certain treatments where appropriate and to use the recommended seed mixtures and techniques to revegetate the area. Successes and failures should be documented and made publicly available to allow for improvements in future reclamation efforts.

Additional information needs to be included regarding the trigger points and actions that will be taken if monitoring indicates that adaptive management is needed. This specificity is necessary in order for adaptive management to meet NEPA's standards for mitigation measures that are likely to be effective and enforced. Monitoring commitments and criteria should be included for ground cover, community composition, and erosion. For much of the affected area of the project, BLM's Technical Reference 1734-6, Interpreters of Rangeland Health, can be used to establish monitoring criteria and procedures. Qualitative and quantitative indicators to be used should be chosen from Table 2 of the technical reference and included in the FEIS.

The project's life is estimated at 50 years, and potentially includes hundreds to thousands of miles of new road disturbance for construction and maintenance purposes. Three years of reclamation

[3] Cheatgrass has the potential to completely alter the ecosystem it invades by increasing fire frequency and preventing the establishment of sagebrush and native grass and forb understory. When cheatgrass becomes a dominant presence on the landscape it can change the fire regime over a very broad area, causing hotter and more frequent fires that destroy nearby sagebrush plants that were not impacted by the original construction project.

monitoring, particularly for long-lived and slow growing species such as sagebrush, is an inadequate time period for judging effectiveness of reclamation.

General principles of effective adaptive management programs include:

- Defining in detail what the adaptive management process will and will not address. BLM should prepare a monitoring protocol that guides whether or not BLM plans to use adaptive management with specific resources. The FEIS should describe the resources and specific indicators that will be measured and used to determine adaptive management so that the public can provide meaningful comments on BLM's proposed approach to adaptive management.
- The FEIS should include a detailed baseline inventory of resource conditions as well as specify indicators that will be used to demonstrate the effects of reclamation efforts.
- A detailed monitoring plan is crucial for assessing potential impacts on resource conditions, ensuring that indicators are measured at regular and consistent intervals. Commitment of adequate resources for administration of this adaptive management process should be firm and sufficient to support the full implementation of adaptive management.
- For all indicators, the FEIS should identify the range of acceptable change from the baseline condition, using best available science, and specify those actions that will be taken in the event that unacceptable levels of change are identified.
- The adaptive management process should be managed so that the public can actively and effectively participate. The proposed corridors cross thousands of miles; citizens interested in the resources affected by the project reside across multiple states.

3. Avian Protection Plan

Avian Protection Plans (APP) are extremely important in terms of identifying specific measures that will be used to avoid, minimize and mitigate impacts. These plans must be developed for the entire line, with public participation, prior to the authorization of this proposed project. The APP must be made available to the public and be available for comment. The DEIS repeatedly refers to proponent APPs on proponent websites, but this does not satisfy NEPA requirements.

> "An agency may not, however, "tier[ ] to a document that has not itself been subject to NEPA review[,] . . . for it circumvents the purpose of NEPA." *Kern*, 284 F.3d at 1073. In short, "A NEPA document cannot tier to a non-NEPA document." *Klamath-Siskiyou Wildlands Ctr.*, 387 F.3d at 998; *see also South Fork Band Council of Western Shoshone of Nev. v. U.S. Dep't of Interior*, 588 F.3d 718, 726 (9th Cir. 2009) ("A non-NEPA document . . . cannot satisfy a federal agency's obligation under NEPA."); *Muckleshoot Indian Tribe v. U.S. Forest Serv.*, 177 F.3d 800, 811 (9th Cir. 1999) (rejecting an agency's attempt to tier an EIS to a non-NEPA document because "[s]uch reliance is impermissible under the NEPA regulations, which only permit tiering to prior EIS's").

The APP should include the following at a minimum: adequate conductor-to-conductor and conductor-to-ground space to prevent avian electrocution, installation of overhead transmission structures with anti-perching devices to reduce perching by avian predators and prevent avian electrocution (Lammers and Collopy 2007, Slater and Smith 2010), mark lines to decrease potential for collisions (marker balls,

clamp-on markers, etc.), use of single solid tubular pole structures to reduce perching, and relocation of development to less sensitive areas (foraging areas, nesting areas, flyways, etc).

The APP should include identification of high-risk areas for collisions and the approaches for reducing collision risk, rather than planning for high-collision areas to be identified after construction. The APP should also be continually evaluated and refined as monitoring data and new innovations become available, in a transparent fashion allowing public input to changes. The Eagle Conservation Plan should include a listing of risk factors, as noted in the USFWS' Draft Golden Eagle Conservation Plan Guidance, and a discussion of these factors for the this project. An APP for this line should incorporate Wyoming Executive Order 2011-5 and Idaho's Conservation Plan for Greater Sage-Grouse, which provide for minimizing impacts on grouse through restricting seasonal activities, including construction and maintenance. *See* Exhibits 1 and 2.

- ***Recommendations:*** The Final EIS should have rigorous use of environmentally-driven Best Management Practices to minimize wildlife impacts. The Environmental Protective Measures need to be more fully addressed so that the public can draw conclusions about impacts to species, and EPM's should be applied uniformly along the route.

  The FEIS should include aggressive weed management and reclamation plans, each followed by scientifically-sound monitoring plans to determine effectiveness. The Final EIS should also include an adaptive management plan to ensure that invasive species concerns or reclamation challenges are fully and promptly addressed. Adequate time-frames need to be considered for reclamation to be monitored for effectiveness. Successes and failures should be documented and made publically available to allow for improvements in future reclamation efforts.

  Thresholds and management actions should be specified in the FEIS.

  An Avian Protection Plan must be developed for the entire line, with public participation, prior to the authorization of this project. The APP should include identification of high-risk areas for collisions and the approaches for reducing collision risk. The Plan should be continually evaluated and refined as monitoring data and new innovations become available.

C. <u>Compensatory Mitigation</u>

Before a rigorous discussion of compensatory mitigation can take place, potential impacts must be comprehensively assessed. For all threatened, endangered and candidate species, this assessment should include: 1) science-based estimates of the direct, indirect, and cumulative impacts throughout the length of proposed line; and 2) how the cumulative impacts of the entire line and related actions add to the other ongoing and reasonably foreseeable impacts throughout the ranges of the targeted species.

For unavoidable impacts, compensatory mitigation is required to replace the loss of habitat and/or other resource functions. Methods of providing compensatory mitigation include resource restoration, establishment (creation), enhancement, and, in certain circumstances, preservation.

Mitigation is an important requirement of National Environmental Policy Act (NEPA). The Supreme Court has stated that "[o]mission of a reasonably complete discussion of possible mitigation measures" undermines NEPA and the ability to assess the severity of environmental impacts. *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 352 (1989). Consistent with BLM's Special Status Species Policy and the agency's ESA Section 4(a)(1) obligations to conserve and recover listed species, the FEIS must state how impacts will be analyzed and mitigation requirements developed. Mitigation should enhance long-term health and viability of the impacted populations through permanent protections and through other protections that last at least throughout the life of the project.

In accordance with BLM policy, the following factors indicate that off-site mitigation is appropriate for this proposed project:

- Gateway West is a major electrical right-of-way project,
- Gateway West would affect resources and values of high public importance; and
- Gateway West would have permanent impacts that cannot be mitigated onsite.

Ecoregional health[4] is critical for maintaining the health of individual ecosystems within the ecoregion. In addition to ensuring that off-site mitigation meets a "*no net loss*" requirement for resources and values lost on the project site and is tied to the species being impacted, BLM should require that *mitigation take place in the same ecoregion as the project site*, to ensure the continued health of the overall ecoregion.

Additions could be gained through some combination of three primary mechanisms; however, requirements should ensure that the majority of mitigation efforts be focused on the first two mechanisms, with the highest priority given to acquisition:

- Purchase of additional private lands to be put in the federal estate under conservation management to guarantee the maintenance of the equivalent or better values and resources lost on the project site. It should be noted that purchase of such lands does not have mitigation value unless they are under threat of loss, or
- Additional conservation designations on existing federal lands which would permanently protect the equivalent or better resources and values lost on the project site, or
- Restoration efforts to improve the quality and quantity of equivalent resources and values off-site.

Mitigation protections will require additional and ongoing monitoring to determine effectiveness, especially given the unique nature of transmission impacts (linear and tall, direct and indirect) and the evolving science addressing these projects. See discussion on effective monitoring and adaptive management (p.15).

[4] The World Wildlife Fund defines an ecoregion as a "large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions." *See* http://www.worldwildlife.org/science/ecoregions/delineation.html

There is an important distinction between the monitoring required to assess effectiveness of mitigation, and research or monitoring completed in lieu of on-the-ground mitigation. We do not support research funding as a substitute for compensatory habitat mitigation applied on the ground.

Ecosystem level planning and strategies should be employed in addition to species-specific analyses. The Endangered Species Act provides that "t]he purposes of this Act are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such endangered species and threatened species[.]" 16 U.S.C. § 1531(b). An assessment tool or evaluation strategy approved by USFWS should be used to quantify the interim and permanent impacts (injury) to habitats (direct, indirect and cumulative) and the ecological services provided by those habitats. This will enable a more accurate, predictive approach to impact mitigation.

While these comments emphasize sage-grouse protection, it should be noted there are several other TES species needing *complete* impact analysis and mitigation planning in the EIS, including pygmy rabbit, wolverine, whitebark pine, and slickspot peppergrass.

1. Habitat Equivalency Analysis

Replacement habitat acreage and ratios will vary with habitat type and quality, geography and topography, legal protections, direct and indirect impacts, and permanency of the impact. We support the proposed use of a Habitat Equivalency Analysis (HEA) as a tool for determining a portion of project impacts to Greater Sage-grouse. An HEA requires that habitat is replaced with like habitat so that there is no net loss in ecosystem services, and the replacement or compensatory habitats should be of equal or better quality to those disturbed by a given project. As with the APP, the FEIS cannot tier to an HEA that has not been made available for public scrutiny[5]. The completed HEA must be presented in a Supplemental Environmental Impact Statement, with the data, methods, and results made available for public comments[6].

Replacement habitats are preferably located in the same geographic area as the impact. However, rather than approaching replacement of impacted habitat acres with a patchwork of small parcels of newly protected land, it can be preferable to identify and protect fewer but larger areas, possibly based in proximity to already protected lands or relatively healthy populations of target species. This approach is incorporated in recent Greater Sage-grouse policies adopted by the State of Wyoming and BLM, and can be expanded to increase its effectiveness. A subcommittee formed by the Idaho Sage-Grouse Advisory Committee recently drafted plans for a statewide mitigation framework, which serves as a supplement to the *Conservation Plan for Greater Sage-grouse in Idaho*. Exhibit 3.

When considering impacts and mitigation measures, the best available science should be used. If successful and made public, the mitigation approaches identified in the HEA could be applied in

[5] "an agency must disclose the technical studies and data upon which it bases a ruling" *American Radio Relay League, Inc. v. FCC*, 524 F.3d227 (DC Cir. 2008)

[6] See 40 CFR § 1500.1(b) ("NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken").

improving siting of future transmission lines. However, steps must be in place to evaluate the proposed mitigation measures where effectiveness is based on number of sage-grouse (Doherty et al. 2010a). Mitigation for unavoidable impacts should rely on science-based processes that quantify what is being lost and replace those losses on-site or nearby when possible. Off-site mitigation is necessary in some instances but should be used with emphasis placed on scientifically defensible habitat improvements and strict development activity restrictions in important habitats.

2. Other Impact Analyses

Direct and indirect impacts of energy development and of habitat fragmentation on sage-grouse are well-documented (see Monograph discussion above).

Indirect effects may include delayed effects on the population, and include landscape change through invasive species, habitat fragmentation, alterations of fire regimes, increased predation pressures, loss of prey base and decreased productivity of wildlife. These effects are harder to quantify, but can be seriously damaging to wildlife populations.

One of the indirect effects of development is changes in wildlife behavior, For example, sage-grouse may leave long-used areas in response to disturbance and changes in habitat. Behavioral avoidance, leaving high quality habitat for lesser-quality habitat, could have population level effects (reduced survival, reduced reproductive success, etc.). Reduced nest success can be compounded by fewer nesting pairs. Displacement and habitat fidelity are significant concerns requiring a cautious and comprehensive approach.

Monitoring for sage-grouse impacts will need to occur over more than a decade. Harju et al. (2010) detected time lags up to a decade in length in sage-grouse population responses to energy development. They did not, however, detect a cessation of responses, indicating that even after 10 years, sage-grouse populations were still reacting to these habitat changes.

- ***Recommendations:*** BLM should require a comprehensive planning and development approach to avoid, minimize and mitigate impacts. The impact analyses and mitigation plans must be made available for full public scrutiny and comment in supplemental releases of information.

  Mitigation, which should be monitored to determine effectiveness, should enhance long-term health and viability of the impacted populations through permanent protections and through other protections that last at least throughout the life of the project. Location of off-site mitigation is extremely important.

D. Candidate Conservation Agreements

In addition to the HEA and compensatory mitigation process introduced in the DEIS, we encourage the BLM and Gateway West to use the legal tools available through the ESA to mitigate habitat losses on both federal and non-federal lands. Candidate Conservation Agreements (CCA) and Candidate Conservation Agreements with Assurances (CCAA) are voluntary conservation agreements between the U.S. Fish and Wildlife Service and one or more public or private entities, for the protection of

candidate species on federal and nonfederal lands. The land user (land owner or lessee) can volunteer to join the Agreement through a Certificate of Inclusion (CI).

To most effectively mitigate the effects of the proposed Gateway West project on the Greater Sage-grouse, a beneficial agreement would be a combination of a CCA and a CCAA. USFWS, BLM, the proponents and other stakeholders could develop the two agreements in tandem, by designing the CCA to be the parent document for the CCAA. Specifically, the CCA can be drafted to address the activities of lessees and permittees on Federal lands, while the companion CCAA can address the needs of candidate species on non-Federal lands.

The CCA/CCAA is a living document. Adaptive management would allow USFWS to make warranted modifications to the original conservation measures in the CCA/CCAA. New conservation measures could be implemented where USFWS found them necessary to facilitate the continued conservation of the grouse. Adaptive management modifications would apply only to future CIs.

The CCA/CCAA approach can be a collaborative effort involving USFWS, BLM, and Gateway West. The CCA/CCAA should target populations of candidate species, and ensure continued ecosystem viability of the species' habitat. The goal of any CCA or CCAA should be a net conservation benefit to both 1) the candidate species, and 2) other species that use the same habitat. This can avoid conservation measures that may aid a certain candidate species but lower the habitat value for other species. This approach was used with the Lesser Prairie-chicken in New Mexico. Exhibit 4.

- ***Recommendation***: Candidate Conservation Agreements (CCA) and Candidate Conservation Agreements with Assurances (CCAA), whose goal should be net conservation benefit, are voluntary tools that should be considered in the FEIS as potential mitigation tools.

VI. State Specific Analyses

This section reviews potential resource impacts and conflicts on a state-by-state basis for Wyoming and Idaho. The comments strive to (1) describe known resource conflicts, and (2) identify locations that will have the least environmental impact, based on the incomplete information provided in the DEIS. Unless specifically noted, we recommend that the proposed routes follow existing transmission and transportation corridors to minimize new disturbances to the landscape and decrease impacts associated with habitat fragmentation. Additionally, these areas are already impacted for wildlife habitat, visual resources, and cultural sensitivity.

Where route segments run through high densities of known raptor nests and roosts, careful and conservative protective measures need to be implemented to the greatest extent possible. This includes, but is not limited to, the use of anti-perching devices (at both water crossings and potential migration corridors), line markers, and single steel pole structures. Raptor nest surveys and protection measures (e.g., GWDEIS TESWL2 and 3.10-34, 35, and 36) must occur pre- and post-construction to

(1) determine collision risk, (2) determine actual mortality, and (3) assist in determining appropriate mitigation measures to avoid take of nests or disruption of breeding activity.

We would like to see the Alternative (Not Studied in Detail) route, which runs along I-80 in Wyoming through Utah, analyzed (DEIS Figure A-1). This route follows the Westwide Energy Corridor. This may be a viable option given the breadth of wildlife concerns for all the routes proposed to travel through Lincoln County, Wyoming. This portion of Lincoln County contains some of the most biologically diverse lands within Wyoming, including wetlands, Cokeville National Wildlife Refuge, big game conflicts (DEIS Figure E.10-3). The National Audubon Society has identified an Important Bird Area (IBA), which overlaps all the analyzed route options near Cokeville. This substantial IBA, referred to as Commissary Ridge Raptor Migration, was identified as a priority area where threatened, restricted-range, biome-restricted and congregatory birds occur.

Pre-siting surveys of bird habitat use and migration pathways should be undertaken prior to the determination of tower locations and arrays. In addition, because wind farms tend to follow transmission lines, pre-siting surveys of raptor and mountain plover nesting areas should be undertaken and these areas should be avoided.

Given the bulk of research to date on other forms of development and human activity, it is realistic to assume that development of approximately 1,150 miles of transmission line will result in (1) direct loss of habitat and (2) displacement due to indirect habitat loss (i.e., avoidance) of big game seasonal ranges. The level of impact will depend on the importance of the habitat (crucial winter range, parturition range, or year-round range) and the other forms of cumulative impacts on a given population. However, impacts can be minimized by developing in brownfields, avoiding important habitat, reducing surface disturbance during construction and operation, aggressively minimize and address invasive species (such as cheatgrass), use of timing stipulations to minimize disturbance during construction activities, and develop a transportation plan which include road design, locations, and speed limits to minimize habitat fragmentation and wildlife collisions/disturbances. Additional Advanced Conservation Practices for terrestrial wildlife species, including big game, can be found in Appendix B.

A. Wyoming: Resource Concerns & Siting

Route segments were examined for conflicts with Greater Sage-grouse core areas, big game crucial ranges and migration corridors, Mountain Plover nesting concentration areas, raptor nest concentration areas and activity, and Wyoming pocket gopher. The Wyoming Game and Fish Department identified many of these species as Species of Greatest Conservation Need. Exhibit 5.

Species identified in the WGFD report as NSS2 (Bald Eagle and Greater Sage-Grouse) are characterized as having imperiled population status with severe limiting factors. Species identified as NSS3 (Wyoming pocket gopher) have vulnerable population status with severe limiting factors. In addition, the Wyoming pocket gopher is listed as a species of management concern by the Wyoming

State Bureau of Land Management, Region 2 of the USDA Forest Service. Due to lack of information but concern for these populations, several species are categorized as NSSU (Ferruginous Hawk, Mountain Plover, Northern Goshawk, and Merlin).

The predicted distribution for Wyoming pocket gopher has been estimated using computer modeling techniques, but additional occurrence locations are needed to validate or improve models (Keinath and Beauvais 2006)." Continuing surveys are suggesting that the Wyoming pocket gopher may be distributed more widely than previously thought. The Gateway West Transmission project does impact Wyoming pocket gopher habitat and therefore, the BLM and projects proponents must engage in Pre-siting Surveys and Monitoring.
Though we do not focus on wetlands in these comments, wetlands serve critical biological functions that benefit a wide range of species. We encourage the review and careful consideration of recent work published by Copeland et al. 2010. The document, Wyoming Wetlands: Conservation Priorities and Strategies, was a collaborative effort between state and federal agencies and partner organizations. The report specifically addresses wetlands along the route proposed for Gateway West.

1. **Consensus Preferred Route:**

Segment 1W: Among the routes analyzed, this segment appears to be the least impactful because it follows an existing 230-kV line. *However*, we are very concerned about the potential for additional renewable development within the Shirley Basin, a dramatic landscape which harbors some of the world's last intact grasslands and a mix of Wyoming big sage communities. This area supports superb fisheries, significant bat roosts, and numerous bird species, including mountain plover, ferruginous hawks, sage grouse and the American white pelican. The Nature Conservancy scientists have identified the Shirley Basin as an area of high biological significance because of its intact grasslands and aquatic habitats. Furthermore, the National Audubon Society has identified an Important Bird Area (IBA) in the basin.

We would support this segment only *if* (1) the Heward substation were eliminated (the presence of this substation could potentially support proposed Dry Creek and Sand Creek wind projects [7], which failed to be addressed in the DEIS and there are (2) assurances that public lands north of the checkerboard will not be available to new renewable energy development activities, as this important basin has already experienced considerable strain due to recent development pressures.

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[7] **Dry Creek Wind Power Project.** Eurus Dry Creek, LLC proposes to construct a wind energy facility consisting of 150 wind turbines, totaling 351 MW. The turbines would be constructed on 3,527 acres of land administered by the BLM. The project is proposed on lands within the Rawlins Field Office, in southeastern Wyoming. The project is in early stages of planning and has the northern, and northeastern portion of the project located in sage grouse core area. The BLM and Wyoming Game and Fish Department met with the Proponent to convey how difficult it will be to develop their project as currently proposed. The Cost Recovery Agreement is under BLM Solicitor review and should be executed by the 3rd quarter 2011.
Sand Creek Wind Project. Big Wind Power Company will likely submit an application for a wind energy project located in the Shirley Basin area in the northern portion of the Rawlins Field Office. The proponent has plans to develop a 1 GW wind energy facility, consisting of approximately 419 wind turbine sites, built in economically viable stages, mostly on BLM land. There is a draft Power Producers Agreement (PPA) for phase 1 of the project (total of 80 MW). Phase 1 would tie into an existing transmission line. The subsequent phases are planned to tie into the proposed future Gateway West transmission line. The company has met with BLM to discuss how to manage phased project development in accordance with NEPA. A Type III ROW application and POD are expected from the proponent by the end of the year. ***Source*:** BLM Hot Sheet August 2011
http://www.blm.gov/pgdata/etc/medialib/blm/wy/information/NEPA.Par.24843.File.dat/hot_sheet.pdf

Also, we recognize concerns from private landowners for the Alternative (Not Studied in Detail) route which runs along the east side of Laramie range. However, given the State's encouragement for renewable generation east of I-25, we propose a new route. This route would follow begin at Aeolus substation and could run along either the route proposed for Wheatland/Chugwater transmission line or the Overland Intertie (DEIS Figure E.24-1).

Segment 2: This segment includes a designated Executive Order two-mile wide transmission line corridor. Concentrating transmission lines through this specific portion of Core Population Areas will help to minimize impacts to Core Population Areas and other natural resources. This segment also runs along existing transmission line routes, along highly disturbed I-8O to Wamsutter.

However, this route also runs through high densities of known raptor nests and roosts, thus requiring careful and conservative protective measures such as anti-perching devices, line markers, and single steel pole structures to the greatest extent possible. Raptor nest surveys and protection measures (e.g., GWDEIS TESWL2 and 3.10-34, 35, and 36) must occur during construction and operation activities to avoid take of nests or disruption of breeding activity. Additionally, the National Audubon Society has identified an Important Bird Area (IBA) just north of the proposed route and west of Rawlins – Shamrock Hills Raptor Area. This IBA is located in the greatest concentration of raptor nests documented amongst the Wyoming routes.

Segment 3: This segment also runs along primarily existing transmission line routes, along highly disturbed I-8O. *However*, this route also runs through high densities of known raptor nests and roosts, thus requiring careful and conservative protective measures such as anti-perching devices, line markers, and single steel pole structures to the greatest extent possible.

Segment 4 (up to Seedskadee National Wildlife Refuge): This segment also runs along primarily existing transmission line routes, along highly disturbed I-8O. This segment includes a designated Executive Order two-mile wide transmission line corridor. *However*, this route does cross the Seedskadee National Wildlife Refuge Important Bird Area. Therefore, care must be taken to minimize impacts to migrating and residential birds. This includes pre-siting surveys to identify areas that should be avoided.

Segment 4A, F ("Feasible Alternative): Among those presented for analysis within Lincoln County (see discussion above), this section appears to have *fewer* environmental impacts. An existing 345-kV transmission line is located along this route, it contains a designated Executive Order two-mile wide transmission line corridor through sage-grouse core area, avoids Cokeville Meadows NWR, and would likely have less impact on migrating raptors (Commissary Ridge). However, because raptors utilize the entire north-south ridgeline of Commisary Ridge as a migration corridor, the siting of the transmission line in Segment 4 should avoid transecting any high elevation north-south ridgelines to reduce the risk to migrating raptors that commonly use such features throughout the West (Goodrich and Smith 2008).

2. Disfavored routes

Segment 1E-B: Strongly opposed because it occurs in greenfield.

Segment 4 (northern-most route, "Proposed Route"): Strongly opposed because it occurs in greenfield.

Segment 4 (southern-most route, "Feasible Alternative – "4B,C" & "4C,E"): These sections do not include a designated Executive Order two-mile wide transmission line corridor, while traversing through multiple sage-grouse core areas. These routes also follow the smallest (230 k-V) transmission lines in the area, with the fewest number of proposed transmission lines following this route. Finally, these ultimately require transmission lines to be built near important wetlands around Cokeville Meadows National Wildlife Refuge. Established in 1993, the Refuge is located on a 20-mile stretch of the Bear River and its associated wetlands and uplands. According to the USFWS, the Refuge supports one of the highest densities of nesting waterfowl in Wyoming, provides nesting habitat to colony nesting bird species, has excellent potential for reintroduction of trumpeter swans, and provides habitat for resident species, including greater sage grouse, mule deer, elk, and pronghorn. To further support the importance of this area, the National Audubon Society has identified the Cokeville Meadows NWR as an IBA.

Segment 4 ("Feasible Alternative – "4B,D" & "4D,E"): Strongly opposed because of important wetland habitat and Cokeville Meadows NWR (see comments above).

Segment 4F ("Feasible Alternative"): Oppose this section because it falls within greenfield & also impacts raptor migration along Commissary Ridge (see discussion on Commissary Ridge in Raptor section, page 37). In addition to serving as a major migration route for raptors along the Rocky Mountain Flyway, this area contains migration corridors for elk, deer, and moose to SE Idaho and Utah.

B. Idaho: Resource Concerns and Siting

We question the need for two separate lines across much of Idaho, particularly given the use of outdated IRP projections. Updated demand projections in the FEIS may show that a single line is sufficient. We also recommend a closer examination of the proposed separation between transmission lines. New recognition of the environmental impacts of transmission line corridors should be brought to the regulating bodies' attention to win smaller approved separation between lines, particularly where resource conflicts are high.

1. Consensus Preferred Routes

The DEIS was published before sufficient sage-grouse analysis or effective stakeholder input had been completed to identify preferred routes. We give recommendations elsewhere in the document for completing sage-grouse analysis. An example of community stakeholder concerns comes from the Owyhee County Task Force, who created Option 9D, and who report to us that Option 9D is misrepresented in the DEIS.

We recommend the proponents complete a community process such as the MSTI Review Project, currently underway and funded by the MSTI proponent (details and contact information included in Exhibit 6). The MSTI Review Project generates least-cost corridor analysis using ecological, engineering, and community inputs from each county on the proposed route.

2. Disfavored Routes

While there is still stakeholder and ecological analysis to be done before preferred routes can be chosen, there are obvious high conflicts for some alternatives mapped in the DEIS.

Segment 9E is disfavored due to the fragmentation and introduction of predator perches into the relatively undisturbed sage-grouse habitat in Owyhee County. The Owyhee County Sage-grouse Local Working Group and the Owyhee County Commissioners have also opposed this route.

Segment 8 is problematic due to the high number of raptor nests within 1 mile of the line (n=301, DEIS p.3.10-17 and 3.10-85). This segment runs through the *largest concentration of nesting raptors in North America* (ibid). These nests identify preferred habitat for raptors, as these contain quality combinations of nesting and foraging habitats that should be protected for use by future nesting raptors. See discussion starting on page 22 for recommendations on how to reduce impacts, which first focuses on avoidance.

Segments 7A and 7B are not in conformance with the Malad MFP. Segment 7A would cross a roadless area with wilderness characteristics.

Segments 7H, I, and J are disfavored as they would all impact significant areas of sage-grouse habitat, and various pieces of the routes are not in conformance with the Cassia and Wells RMP's, the Twin Falls MFP, or the Sawtooth Forest Plan. Segments 7I and J are of particular concern as they would impact the highest breeding density class (top 25%) for sage-grouse (see Exhibit 7, route maps with sage-grouse breeding density). Our Nevada co-signer, the Nevada Wilderness Project, expresses concerns about the cumulative impacts of fire and transmission routing on the proposed Nevada section of Segment 7.

Segment 5B is disfavored as it would cross a 75% breeding density area for sage-grouse.

Where MFP, RMP, or Forest Plan amendments are proposed to accommodate greenfield routing, we are skeptical that BLM's FLPMA responsibilities can be upheld. The existing land use plans in Idaho are often dated and have limited protections for special status species and for habitat. Revising the plans to accommodate further habitat disturbance will likely result in inadequate species protections.

VII. Species of Special Concern

A. Greater Sage-grouse *(Centrocercus urophasianus)*

Sage-grouse are landscape specialists—requiring large, intact sagebrush habitats. Sage-grouse rely on different types of sagebrush habitat to satisfy their requirements during different seasons of the year, 75 Fed. Reg. at 13915, with the annual range of a sage-grouse encompassing up to 2,700 km^2 (Knick and Connelly 2011). Damage to even one of its seasonal habitats can impact sage-grouse. Because sage-grouse are a landscape-scale species, ensuring the species' survival requires comprehensive analysis of remaining habitats and populations on a range-wide basis, and then adopting a range-wide conservation plan to ensure that adequate regulatory mechanisms are in place to protect the species across its range. Indeed, the U.S. Fish and Wildlife Service has recognized this basic fact, explaining, "Meaningful restoration for greater sage grouse requires landscape, watershed, or eco-regional scale context rather than individual, unconnected efforts." *See* 75 Fed. Reg. at 13917.

1. Science and Recommendations from USFWS

The USFWS "Endangered Species" page summary of the 2010 "warranted but precluded" finding summarizes the status of this species:

> "Evidence suggests that habitat fragmentation and destruction across much of the species' range has contributed to significant population declines over the past century. If current trends persist, many local populations may disappear in the next several decades, with the remaining fragmented population vulnerable to extinction." Exhibit 8.

Notably, the USFWS Finding identified power lines as directly affecting greater sage-grouse "by posing a collision and electrocution hazard" (Braun 1998, pp. 145-146; Connelly *et al*. 2000a, p. 974), and can have indirect effects by decreasing lek recruitment (Braun *et al*. 2002, p. 10), increasing predation (Connelly *et al*. 2004, p. 13-12), fragmenting habitat (Braun 1998, p. 146), and facilitating the invasion of exotic annual plants (Knick *et al*. 2003, p. 612; Connelly *et al*. 2004, p. 7-25) (page 18). Additionally, sage-grouse could be impacted through a direct loss of habitat and human activity (especially during construction periods) (page 44).

The decision by the USFWS was preceded by intense interest in sage-grouse. In 2004, the USFWS used several scientific studies to develop recommendations about impacts of wind energy development on grouse species. Due to various structural factors, including height, the USFWS recommended avoiding placement of wind turbines within 5 miles of greater sage-grouse and Columbian sharp-tailed grouse leks. The science reviewed in developing this recommendation is also relevant to potential impacts of transmission lines on grouse, and the agency should avoid placing transmission lines within 5 miles of sage-grouse leks. Exhibit 9 at 1.

The USFWS' analysis in the March 2010 finding underscores the many increasing threats facing sage-grouse populations and remaining habitats, including from agriculture, grazing, infrastructure, energy development (both traditional and renewable energy sources), invasive weeds and fires, climate change, West Nile virus, and others. *Id.*

Adverse impacts of power lines are specifically identified and discussed by the USFWS here as contributing to the decline of sage-grouse by contributing to habitat fragmentation, causing direct losses of birds from increased predation, and causing sage-grouse to abandon historic habitat through which power lines are constructed. *Id.,* 75 Fed. Reg. at 13927-29. The "warranted" finding also addressed in detail the inadequacy of existing regulatory mechanisms to protect greater sage-grouse populations and habitats from these many threats – including the inadequacy of BLM's management regime. *Id.*, 75 Fed. Reg. at 13973-82.

The science reflected in the USFWS' March 2010 Finding underscores that Greater sage-grouse are a landscape level species that relies on large, interconnected patches of sagebrush, and that protecting these remaining habitats from further loss and degradation – including habitat fragmentation – will be vital to ensuring that sage-grouse survive as a species into the foreseeable future. *See* 75 Fed. Reg. at 13917-62.

We adopt and incorporate by reference the USFWS' discussion and analysis of current sage-grouse populations, habitat losses, threats, and the inadequacy of existing regulatory mechanisms as set forth in the "warranted" part of this finding. The March 2010 "warranted" finding and supporting analysis cited and followed a host of scientific data and literature, representing the best available scientific information on current sage-grouse population and habitat trends and threats.

These include the 2004 WAFWA Conservation Assessment and the suite of articles published as a "monograph" in the journal *Studies in Avian Biology*, as well as much other scientific data and literature. *See id.,* 75 Feg. Reg. at 13912-88.

2. Science from *Studies in Avian Biology*

Some of the premiere sage-grouse researchers came together in a peer-reviewed journal, *Studies in Avian Biology*, to review the impacts of energy development on this iconic bird (Knick and Connelly 2011). The cumulative impacts of various activities on the landscape should not be ignored, especially those that fragment the landscape. Contributing authors, Naugle et al. (2011), state "recent research demonstrated that sage-grouse populations declined when birds behaviorally avoid infrastructure in one or more seasons (Doherty et al. 2008), when cumulative impacts of development negatively affect reproduction or survival (Aldridge and Boyce 2007) or both (Lyon and Anderson 2003, Holloran 2005, Kaiser 2006, Holloran et al. 2007). Avoidance of energy development reduces the distribution of sage-grouse and may result in population declines if density dependence, competition or displacement into poor-quality habitats lowers survival or reproduction among displaced birds (Holloran and Anderson 2005, Aldridge and Boyce 2007) (page 15 of 49)."

Specifically, the chapters in the monograph report the following:

- Movements from lek sites used for breeding to nesting locations can exceed 25 km (Holloran and Anderson 2005) and seasonal ranges can be >80 km apart (Connelly et al. 1988). *See* Ch.1, p.4.

- Populations of sage-grouse have been considered distinct when they are separated from adjacent populations by at least 20 km of inhospitable and unoccupied habitat (Connelly et al. 2004). *See* Ch.5 p.13.
- An early synthesis of sage-grouse biology and management guidelines indicated that most females nest within 3.2 km of a lek (Braun et al. 1977), but recent literature suggests that many females nest farther from leks than previously suspected. *Id.,* p.15.
- Multiple studies have recommended that sage-grouse populations should be managed at large spatial scales (Connelly et al. 2000, Connelly et al. 2004, Holloran and Anderson 2005, Walker et al. 2007, Aldridge and Boyce 2007). This study suggested an endogenous sagebrush landscape scale between 4.5 and 9.0 km to which sage-grouse dispersal and movement patterns have adapted. Growing evidence suggests that sage-grouse respond to large scales that exceed currently applied management scales of no disturbance within 0.5 km around leks and within 3.2 km around leks during the breeding season (15 March–15 June) in areas with coal-bed natural gas extractions (Walker et al. 2007, Doherty et al. 2008). *See* Ch.14, p.30.
- Conservation of sagebrush within 5 km of leks has been recommended to maintain the most locations used for nesting and early brood-rearing by nonmigratory populations, whereas 18-km radii have been recommended for migratory populations (Wakkinen et al. 1992, Connelly et al. 2000a, Holloran and Anderson 2005). Characteristics at 54-km radii may influence seasonal movements and also incorporate habitats used outside the breeding season (Swenson et al. 1987, Leonard et al. 2000). *See* Ch.18, p.11.
- The most significant spatial scales for environmental predictors were proportion of sagebrush within 54 km of the lek ($P < 0.05$), proportion of burned area within 54 km of the lek ($P < 0.01$) and level of human footprint within 5 km ($P < 0.01$) (Table 4). *See* Ch. 18, p.23.
- Power line poles along transmission corridors provide nest and perching opportunities for Common Ravens (*Corvus corax*), American Crows (*C. americanus*), and raptors (Reinert 1984, Knight and Kawashima 1993, Steenhof et al. 1993, Lammers and Collopy 2007). Ravens are primary predators on sage-grouse and other prairie grouse nests (Coates et al. 2008, Manzer and Hannon 2005) and can travel >10 km from these locations (Boarman and Heinrich 1999). *See* Ch.13, p.54.
- Lek count trends were negatively related to proximity to the closest communications tower and to the number of towers within 18 km. Research has suggested that sage-grouse avoid transmission lines in general and during the breeding season (Ellis 1985, Braun 1998), and Lesser Prairie-Chickens also avoid them in general and when nesting (Hagen 2003, Pitman et al. 2005). *See* Ch.17, p.27.
- The cumulative effects of relatively low levels of anthropogenic features in landscapes surrounding leks were associated with reduced sage-grouse population trends. Consistent patterns in population trends across management zones regardless of differences in the suite of stressors in each zone suggest functional similarities between stressors. Lek count trends were lower when human footprint scores exceeded 2 at leks, or when median scores exceeded 3 within either 5 km or 18 km of a lek. *Id.*, p. 30.
- Impacts to leks from energy development were most severe near the lek, remained discernible out to distances >6 km (Holloran 2005, Walker et al. 2007a), and have resulted in the extirpation of leks within gas fields (Holloran 2005, Walker et al. 2007a). *See* Ch. 21, p. 15.

Based on these and similar considerations, the U.S. Fish and Wildlife Service has recently recommended that wind turbines not be constructed within five miles of active leks. *See, e.g.*, Comments of USFWS on Antelope Ridge Wind Project, May 17, 2010, at 3 (noting that the "5-mile protective zone for wind project features helps buffer sage-grouse against increased mortality (both human-caused and natural), habitat degradation and fragmentation, and disturbance"). A similar 5-mile buffer around active sage-grouse leks should be employed by BLM here, because of the impacts that newly-constructed transmission towers and power lines may have upon sage-grouse populations and habitats.

3. BLM Policy

The Federal Land Policy and Management Act of 1976 (FLPMA) mandates that BLM public lands "shall" be managed "for multiple use and sustained yield," and to prevent "unnecessary or undue degradation" of public lands. See 43 U.S.C. § 1732(a) & (b). Pursuant to these and other statutory authorities, BLM has adopted a Special Status Species Policy, Section 6840 of BLM's Manual, with which BLM must comply in analyzing the proposed line and determining whether to approve rights-of-way over the public lands for it. The Special Status Species Policy mandates that BLM "shall ensure that actions authorized, funded or carried out by the BLM do not contribute to the need for the species to become listed." *See* BLM Manual 6841.06C.

In 2004, BLM adopted a National Sage-grouse Habitat Conservation Strategy pursuant to its FLPMA duties and the Special Status Species Policy then in force. Relevant to this project, the Strategy states that BLM should "[f]ocus project design and approval on avoiding or minimizing habitat degradation" and identify "mitigation measures at off-site locations to offset unavoidable sage-grouse habitat alteration and losses." *See* Strategy, § 1.4.1 at p. 15. Moreover, the Strategy states that BLM must "[e]ncourage placement of new utility developments (powerlines, pipelines, etc.) in transportation routes in existing utility or transportation corridors to minimize fragmentation of sage-grouse habitat." *See* Strategy, § 1.4.1 at p. 16 (emphasis added).

In March 2010, BLM supplemented the Strategy with Instruction Memorandum No. 2010-071, Gunnison and Greater Sage-grouse Management Considerations for Energy Development (Supplement to the National Sage-Grouse Habitat Conservation Strategy), Mar. 5, 2010. This IM establishes as BLM policy that Gunnison sage-grouse and Greater sage-grouse are BLM sensitive species that are to be managed to promote their conservation and to minimize the need for listing under the ESA, in accordance with the BLM's special status species policy (BLM Manual 6840).

Therefore, when necessary to maintain sustainable sage-grouse populations across the broader landscape within the state, field managers will implement an appropriate combination of protective actions in "priority habitat." Generally speaking, "priority habitat" is the habitat of highest conservation value relative to maintaining sustainable sage-grouse populations range-wide. Priority habitat will be areas of high quality habitat supporting important sage-grouse populations, including those populations that are vulnerable to localized extirpation but necessary to maintain range-wide connectivity and genetic diversity. *See* IM 2010-071.

As explained below, these and other provisions from the Strategy underscore BLM's duty to prevent the proposed power line from adversely impacting existing sage-grouse populations and habitat – including selecting routes which best avoid sage-grouse areas. And they require that the EIS consider a full range of off-site mitigation measures, including sage-grouse habitat restoration and compensated grazing retirement.

Under the Special Status Species Policy, BLM State Directors may designate "sensitive" species that are native species of concern for various reasons, including because they "could become endangered or extirpated from a state, or within a significant portion of its distribution in the foreseeable future"; are "under status review" by U.S. Fish and Wildlife Service; or are "undergoing significant current or predicted downwards trends in population or density. . . ." *See* BLM Manual 6840.06.E. Greater sage-grouse are designated as a "sensitive" species by Idaho and Wyoming BLM; and as noted above, have been determined by the USFWS to be a "candidate" species that "warrants" listing under the Endangered Species Act. The FEIS must fully comply with the sensitive species policy and ensure that the project does not adversely affect sage-grouse.

4. State of Wyoming Policy

To address the need to protect wildlife resources as wind energy and associated infrastructure were developed in the state, in 2010 the Wyoming Game and Fish Department developed recommendations based on science. Exhibit 10. Considerable portions of the document focused on sage-grouse, as they were noted as being "highly sensitive to disturbances and habitat modifications" Exhibit 10 at 8. Wind development, such as Chokecherry and Sierra Madre projects, alter site characteristics through "placement of tall structures (towers and power lines) and road networks (Braun 2006 and others). Prairie grouse did not evolve with these types of features in their environment." Id. at 7. Specific impacts identified by researchers "from power lines include: behavioral avoidance, habitat fragmentation, collisions, and increased predator access (Aldridge 1998, Braun 1998, Connelly et al. 2000, Boisvert 2002, Braun et al. 2002, Hagen 2003, Wolfe et al. 2003a, 2003b, Pitman 2003, Connelly et al. 2004, Hagen et al. 2004, Patten et al. 2005 and Hoffman and Thomas 2007). Exhibit 10 at 8.

Governor Mead affirmed Wyoming's commitment to Greater Sage-grouse conservation by issuing Executive Order 2011-5 (replacing Order 2010-4), which incorporates input from a broad-based task force and intense review of the emerging science on impacts of energy development. Exhibit 1. Specifically, the Executive Order identified a two-mile wide transmission line corridor in south central and southwestern Wyoming, through Core Population Areas, in an effort to reduce impacts to Core Population Areas and other natural resources. The State stressed that new transmission lines sited outside this corridor within Core Population Areas should not be constructed unless it can be demonstrated by the state agency that the activity will not cause declines in Greater Sage-Grouse populations. Exhibit 1 at 3-4. The DEIS states "The Project would contribute to the permanent loss of suitable sage-grouse habitat and possible disturbances to birds." and "The cumulative effects of the Gateway West Project on the greater sage-grouse when taken together with past, present, and reasonably foreseeable future projects would be substantial."

5. WAFWA Findings

On June 21, 2011, the Western Association of Fish and Wildlife Agencies wrote USFWS to emphasize the precarious status of the sage-grouse, and the need for "a long-term habitat solution that both Federal agencies and state wildlife agencies must work together to address." Exhibit 11 at 1. The letter concluded by emphasizing the urgency of immediate and coordinated efforts:

> [T]ime is of the essence because a final listing determination for the Greater sage-grouse will be made by USFWS at the end of Fiscal Year 2015. Thus, we strongly urge the BLM to move quickly and determine a course of action in developing adequate regulatory mechanisms for the conservation of the Greater sage-grouse. [. . .] Thus, we request a commitment from all the agencies involved that all employees understand the importance of the conservation of sage-grouse and the steps we as the leaders of our respective agencies have chosen to conserve the bird and its habitat. *Id*. at 3.

6. Sage-Grouse and the Proposed Gateway West Project

In 2011, the BLM begun taking serious steps towards meaningful conservation measures in its National Greater Sage-Grouse Planning Strategy. We understand the BLM's goal is to provide for long-term sage-grouse conservation, habitat protection and species recovery that would make federal Endangered Species Act protection unnecessary in the coming years. To date, the BLM has not completed the preparation and implementation of this range-wide conservation plan.

Despite the White House recently identifying Gateway West as one of the seven pilot projects for the new Rapid Response Team for Transmission (RRTT), the BLM should not complete analysis or make a final decision on the Gateway West transmission ROW until interim guidelines related to the National Planning Strategy are released. The proposed transmission line, if it moves forward ahead of the National Strategy, will likely further fragment and degrade remaining sage-grouse habitat and populations and bring the species closer to a listing decision.

The area proposed for placement of the transmission line includes important sage-grouse habitat in both Idaho and Wyoming. Recent range-wide breeding density analysis performed for the BLM further stresses the importance of specific areas to sage-grouse, especially the southern most route options in eastern Idaho. Exhibit 7. Specific portions of routes fall within areas that contains the top 25 percent of the breeding population within Management Zone IV (Doherty et al. 2010b).

Furthermore, the recent USFWS 2010 Findings state, "Southwestern and central Wyoming and northwestern Colorado in MZ II has been considered a stronghold for sage-grouse with some of the highest estimated densities of males anywhere in the remaining range of the species (Connelly *et al*. 2004, pp. 6-62, A5-23). Wisdom *et al*. (in press, p. 23) identified this high-density sagebrush area as one of the highest priorities for conservation consideration as it comprises one of two remaining areas of contiguous range essential for the long-term persistence of the species" (Exhibit 12, page 35). Therefore, we are concerned that the Gateway West transmission line will cause significant adverse impacts to sage-grouse if improperly sited. Leks, nearby nesting and brood-rearing habitats, and winter habitat should be avoided.

Because the proposed line would traverse significant amounts of grouse habitat, the FEIS must consider the cumulative impacts of the proposed transmission line on sage-grouse in combination with other existing and planned energy development.

Simply referencing lek areas is insufficient to analyze impacts on sage-grouse, and to protect sage-grouse from adverse impacts of the transmission line, for several reasons, including: (a) the use of active leks to identify sage-grouse areas does not incorporate nesting, brood-rearing, summer, and winter habitats, all of which are essential to sage-grouse survival and reproduction; and (b) the best available science indicates that far more extensive 'buffers" are necessary to protect sage-grouse from adverse impacts of infrastructure developments than currently called for by BLM guidance documents. The chapters in the *Studies in Avian Biology* monograph provide substantial data supporting these points, showing that existing BLM "buffers" are inadequate to protect sage-grouse from adverse impacts of infrastructure development, including power lines (Knick and Connelly 2011).

7. Need for supplemental release of information

At a minimum, the FEIS must fully analyze the best available data on sage-grouse populations and habitats that may be affected – directly, indirectly, and as a result of cumulative impacts – in the context of this wealth of scientific information on human action impacts (such as transmission lines and towers) on sage-grouse. Sage-grouse impact analysis and mitigatio planning, including the Avian Protection Plan and Habitat Equivalency Analysis must be presented in a supplemental release of information, with the data, methods, and results made available for public comments.

BLM must fully study the adverse impacts posed by the proposed route -- not just upon active lek areas but all current sage-grouse habitats within an 18-km distance from the proposed route (Knick and Connelly 2011). And as described in our mitigation section, BLM must evaluate a full range of alternatives, including routing and mitigation measures, to prevent adverse impacts to sage-grouse populations and habitat.

8. Recommended Protections

Again, the **BLM should not make a final decision on the Gateway West transmission line until interim guidelines related to the National Planning Strategy are released**. It is likely that these interim guidelines will include guidance on conservation measures developed by leading experts from the National Technical (Science) Team (personal communication with Dwight Fielder on 8/26/11). Receipt of this critical component will allow us to provide more specific comments on the proposed mitigation measures.

Protections for sage-grouse will include careful siting as well as restrictions and Best Management Practices during construction and operations. While siting recommendations have traditionally focused on lek locations, new information is available in both Idaho and Wyoming regarding seasonal use of habitats away from lek and early nesting grounds. Siting decisions should be informed by lek location, as discussed below, and should also be informed by IDFG's new seasonal habitat modeling and by Wyoming core area designations.

The **temporal and spatial restrictions the proponents have committed to in the DEIS are severely inadequate** (DEIS Appendix C-5, p.13). The DEIS states that transmission siting recommendations range from 0.25 miles to 5 miles distance from leks, with their selection being "surface disturbance would be prohibited year-round within 0.25 miles of previously documented leks." (page 8). Additionally, the DEIS draws this conclusion about the Project, as proposed:

> "Given the extent of the direct and indirect impact on greater sage-grouse and their habitat, as well as the lack of a compensatory mitigation plan that is currently acceptable to both the Proponents and the state and federal agencies, the Project's construction and operations may impact individuals or habitat, and is likely to contribute to a trend toward federal listing or loss of viability for the greater sage-grouse (R4 language). For the same reasons, the Project may adversely impact individuals and is likely to result in a loss of viability in the Planning Area, or cause a trend towards federal listing (R2 language)." DEIS 3-11.72

Given this conclusion, the indication toward stronger protection for sage-grouse is clear. The 0.25 mile and 0.65 restrictions have long been recognized as being without scientific merit and an inadequate protective measure to maintain lek activity (Holloran 2005, Walker et al. 2007). Instead, given the research from oil and gas development, the agency should **avoid placing transmission lines within 5 miles of sage-grouse leks, which is also recommended by the USFWS** (see discussion on p. 23). Furthermore, the timing stipulations in the DEIS (March 1 to May 15) poses a serious threat to hens and young. Most hens are still sitting on nests in May 15, which is the last day of recommended protections from construction activities. In fact, peak hatch generally occurs in early June and is followed by early brood rearing, which also occurs near nesting habitat. Therefore, we strongly suggest that protections be extended until July 15 to be meaningful and maintain healthy future populations. The timing stipulation from **March 1 to July 15 should apply** to the entire core area in Wyoming (within 2 miles of a lek outside core area) and for those portions of transmission line that run through Key Habitat areas in Idaho (DEIS Figure E.11-3).

Impact minimization for sage-grouse will be important throughout construction and operation phases. The most comprehensive habitat-based guidance documents are the **Wyoming Governor's Executive Order 2011-5** on the Greater Sage-grouse Core Area Protection and **BLM Instruction Memorandum No. 2010-071** on the Gunnison and Greater Sage-grouse Management Considerations for Energy Development. Exhibits 1 and 13. These focus on avoiding grouse core areas and the identification of appropriate transmission corridors. These practices will also benefit other ground-nesting avian species in the sagebrush ecosystem.

The EO provides stipulations on surface disturbance, surface occupancy, seasonal disturbance, and transportation and other disturbance designed to minimize development impacts in general that should be adhered to with transmission lines. When traversing core areas, the transmission route should follow the EO's designated transmission corridors. Finally, the EO offers additional guidance on how to minimize impacts outside of core areas. The U.S. Fish and Wildlife Service (USFWS) supports the EO approach as stated in the attached letter to Wyoming Governor's office:

> "[T]he Service believes the Core Population Area Strategy for the Greater sage-grouse provides an excellent model for meaningful conservation of sage-grouse if fully supported and implemented." Exhibit 14.

Generally, we recommend that BLM analyze and plan for this proposed ROW in coherence with the agency's National Planning Strategy, offering maximum protections and recognizing that sage-grouse impacts occur over periods of 10 years or more (Harju et al. 2010) so we are still discovering their extent.

B. <u>Columbian Sharp-Tailed Grouse</u> *(Tympanuchus phasianellus columbianus)*

1. Conservation Status

The Columbian sharp-tailed grouse (CSTG) is one of six subspecies of sharp-tailed grouse. "It is endemic to big sagebrush (*Artemisia tridentata*), shrubsteppe, mountain shrub, and riparian shrub plant communities of western North America. The subspecies currently occupies less than 10 percent of its historic range, with only three meta-populations remaining in central British Columbia, southeastern Idaho and northern Utah, and northwestern Colorado and south-central Wyoming. Within Region 2 of the USDA Forest Service (USFS), this grouse formerly occurred in as many as 22 counties in western Colorado and in portions of 11 counties in west-central, southwestern, and south-central Wyoming. Today, the core distribution for CSTG occurs in southeast Idaho and northern Utah, while Wyoming contains small, fragmented populations.

Of the sharp-tailed subspecies, Hamerstrom and Hamerstrom 1961 stated that the CSTG has experienced one of the greatest declines in abundance and distribution. To that end, CSTG have been petitioned twice for listing under the federal Endangered Species Act and are currently recognized as a "Species of Greatest Conservation Need" by the Wyoming Game & Fish Department. In Idaho, Sharp-tailed grouse were recently introduced into historical range in southern Twin Falls County and southeastern Owyhee County. While hunting is permitted in some counties in Idaho, Twin Falls County, Owyhee County and most of Cassia County are closed to the hunting of sharp-tailed grouse.

The Utah Division of Wildlife Resources directly connects transmission lines to detrimental impacts to grouse populations:

> "For sharp-tailed grouse, fragmentation and loss of habitat has been the result of several factors including increased building of roads, the spread of housing developments, powerline construction and the destruction of riparian areas" Exhibit 15 at 2.

This is supported by a technical conservation assessment that was prepared for the U.S. Forest Service (Hoffman and Thomas 2007), indicating:

> "The primary threats to the CSTG are all human-related. Foremost are habitat loss and degradation caused by conversion of native habitats to pasture and croplands, overgrazing by

domestic livestock, energy development, use of herbicides to control big sagebrush, alteration of natural fire regimes, invasion of exotic plants, and urban and rural expansion.

Roads, railways, power lines, communication corridors, fences, water developments, landfills, and other facilities and activities associated with urbanization together greatly influence CSTG and their habitats. Exhibit 16.

2. Recommended Protections

The USFS technical conservation assessment further states:

> "Despite the proximity of some leks to large transmission lines, evidence from studies of radio-marked sharp-tailed grouse suggest that they seldom use otherwise suitable habitats under or immediately adjacent to these lines for nesting or brood-rearing (Boisvert 2002, Collins 2004). Avoidance of overhead structures probably represents an innate predator-avoidance behavior." Exhibit 16 at 3, 79, 80.

This is supported in the DEIS (p.3.11-91), which predicts that disturbance would be greatest during construction because CSTG are ground nesters and sensitive to ground clearing activities.

Due to the CSTG extreme decline in both abundance and distribution across the West, we strongly suggest that further CSTG habitat loss and/or fragmentation be avoided by not developing transmission corridors through important habitat - specifically close to leks and nearby nesting and brood-rearing habitats. These important habitats should be avoided. Furthermore, Giesen and Connelly (1993) suggest avoiding vegetation manipulation within a 1.25-mile (2 km) radius of the active lek in order to protect the nesting and brood-rearing habitats of CSTG. Exhibit 17 at 331.

Additional guidance on minimizing disturbance in sharp-tailed grouse habitats is found in the 1200 series of the Colorado Oil and Gas Conservation Commission rules, established in consultation with the Colorado Division of Wildlife to reduce the impacts of oil and gas development in Colorado. Exhibit 18. The protocols and guidance set forth in these rules are instructive for management approaches to avoid, minimize and mitigate impacts of transmission projects to wildlife habitat.

Finally, there should be consistency in stipulations for grouse leks. As previously noted for Greater Sage-grouse, the ¼ mile NSO is well documented to be insufficient to maintain lek activity (Holloran 2005, Walker et al. 2007). Instead, the agency should avoid placing transmission lines within 5 miles of leks. Finally, because they are sensitive to ground clearing activities and they brood and rear young near leks, the timing stipulations in the DEIS (begins March 1) should be extended until July 15.

C. <u>Mountain Plover</u> (*Charadrius montanus*)

1. Conservation Status

The mountain plover is a native bird of short-grass prairie and shrub-steppe landscapes. Wyoming recognizes the protections accorded to the mountain plover as a Neotropical Migratory Bird. The

plover is ranked G3/S2 (Vulnerable Globally/Imperiled in Wyoming) by NatureServe.[8] Mountain plovers are not found in Idaho.

The Wyoming BLM includes the mountain plover on its "Sensitive Species" List (code = SSL). BLM Sensitive species are species that could easily become endangered or extinct in the state including (a) species under status review by the USFWS/ National Marine and Fisheries Service, (b) species whose numbers are declining so rapidly that Federal listing may become necessary, (c) species with typically small or fragmented populations, and (d) species inhabiting specialized refugia or other unique habitats.

2. Recommended Protections

Predators, disease, and parasites are not believed to have a significant effect on mountain plover populations, yet their population is plummeting and their range shrinking. Once widely distributed across the Great Plains and tablelands along the Rocky Mountains, Wyoming is now one of this plover's strongholds.

The best available population data comes from Breeding Bird Surveys, which collectively estimate breeding birds in Wyoming to be 2,000 to 5,000 individuals. Data collected by this survey from 1966 to 1993 reveal that the plover has been declining by an average rate of 3.7 percent a year. This finding is supported by multiple reports of mountain plover declines on their California wintering grounds.

Habitat loss and disruption are this species' greatest threats. Mountain plovers possess intense habitat fidelity, making them highly sensitive and vulnerable to habitat disturbance or destruction. Oil and gas exploration and extraction activities have severely impacted mountain plover habitat. Transmission lines will contribute to added destruction and fragmentation of this habitat.

Relatively large concentrations of breeding mountain plovers occur in Montana and Colorado. In 2002, all known breeding locales in the state of Wyoming were identified to define areas of concentrated sightings in the Laramie, Shirley, Washakie, Great Divide, and Big Horn basins. In 2003, distance sampling was used to estimate breeding bird densities in these five areas. BLM biologists calculated a minimum population estimate of 3,393 birds for Wyoming.

Questions arise concerning the negative impacts of transmission lines on mountain plover populations when considering management recommendations set by the Wyoming Bureau of Land Management. In part, these recommendations provide:

Mountain plover management should focus on maintaining short, sparse vegetation through protection of prairie dog towns, grazing by livestock/buffalo, and/or prescribed burning (Wershler 1989, Knopf 1996). Off-road vehicle access should be restricted between 1 April and 1 August in areas identified as plover habitat. Areas of potential plover habitat should not be converted to agriculture nor have "range improvements" that increase forage for livestock (particularly planting exotic grasses). The Conservation Reserve Program of the Farm Bill is especially counter-productive relative to protection,

[8] http://www.natureserve.org/explorer/servlet/NatureServe?post_processes=PostReset&loadTemplate=nameSearchSpecies.wmt&Type=Reset

in that even where native grasses are planted, those grasses die out unless given the "competitive advantage" of grazing that puts pressure on mixed and exotic grasses. Efforts should be made to reduce the likelihood of invasion by non-native species such as (but not restricted to) cheatgrass, leafy spurge, and knapweed.

Disturbance of landscapes is well-accepted as a contributor to the introduction and spread of non-native, invasive plants. Construction and the long-term maintenance of utility right-of-ways have historically led to the introduction of non-native plants. In instances where invasive plants are not present in utility rights-of-ways pesticides (herbicides) are often the tool used to combat them. Herbicides can be harmful to ground-nesting birds and especially to developing chicks. The FEIS should assess and describe how the invasion of non-native plants will be 1) prevented and 2) mitigated without disturbance to mountain plovers and their habitats. Invasion and encroachment of non-native plants is an issue that needs to be comprehensively addressed across the project ROW.

The BLM should consider the above facts as attempts are made to locate environmentally sustainable transmission lines. Morrisson (2006) and other researchers have suggested that prior to infrastructure development (wind farms, in particular) the project area should be thoroughly surveyed for nesting habitat and to determine bird habitat utilization and migration patterns. A clear understanding of habitat use, including predator/prey relationships is essential for locating transmission lines away from high-value bird habitats.

On the nearby Foote Creek Rim facility, wind turbine development along the southern part of the rim caused the area to be abandoned as nesting habitat by mountain plovers. Johnson et al. (2000) showed a steady decline in estimated population of breeding mountain plovers along the Foote Creek Rim from 60 in 1995 to 18 in 1999. Plover nesting activity also appeared to be displaced from areas where construction activity was underway (id.). According to this study, Reduced use of the southern portion of Foote Creek Rim by mountain plovers may be related to behavioral avoidance of operating turbines and/or construction and maintenance activities, reduced habitat effectiveness caused by the presence of roads, turbine pads, and other ground disturbance, or a combination of the above (Johnson et al. 2000: 31).

VIII. Raptors

A. General Discussion – Key Raptor Areas, Nesting & Migration Routes

Because raptors feed at the top of food pyramids, inhabit most ecosystems, occupy large home ranges, and are sensitive to environmental contamination and other human disturbances, they serve as important biological indicators of ecosystem health (Bildstein 2001). They are documented utilizing considerable swaths of habitat along portions of the Gateway West proposed transmission route as well as the alternate routes.

The proposed and alternate routes travel through important raptor habitat, as supported by the BLM's own designation of **Key Raptor Areas** (KRAs). The route near Rawlins passes through the southern end of a substantial KRA, Shamrock Hills. The route also passes very near four other KRA's, which are all likely utilized by raptors. These three KRAs were among 223 identified by BLM field offices in the 1998 Raptor Research Report, because they contained unusually high raptor nesting, migration, or wintering concentrations that deserved special consideration during decision making (Olendorff et al. 1989). The FEIS should include discussion and management protections for possible KRAs in the remaining BLM field offices in Wyoming and Idaho. Unfortunately, these areas have not been acknowledged by the BLM in the DEIS, defeating the purpose of the KRA's, to provide guidance to future planning and management actions and falling through on the BLM's commitment to "protect and manage raptor habitats on public lands to the best of its ability within the framework provided by the Federal Land Policy and Management Act (FLPMA), BLM's multiple-use mandate from Congress."

The Proposed Route had two segments that had **high numbers of raptor nests** (DEIS p. 3.10-17). Segment 2, near Rawlins, had the highest number of prairie falcon nests (one of the two most common nesting raptors documented, Figure E-10.5). Segment 8, near the terminal end in Idaho, had the highest number of raptor nests within 1 mile of the line (n=301, DEIS p.3.10-17 and 3.10-85). This segment runs through the *largest concentration of nesting raptors in North America* (ibid). These nests identify preferred habitat for raptors, as these contain quality combinations of nesting and foraging habitats that should be protected for use by future nesting raptors.

Though inadequately addressed, the DEIS does reference **Commissary Ridge as a major raptor migration route,** where Golden Eagles were among the five most common species observed (DEIS p. 3.10-16). HawkWatch International, a respected research organization, has recorded an average passage of 3,665 raptors each fall and an average of 268 Golden Eagles (*Aquila chrysaetos*), 158 Bald Eagles (*Haliaeetus leucocephalu*s), and 12 unknown eagles (Mika and Hawks 2011). This important North-South migration route is located along the Rocky Mountain Flyway (Hoffman et al. 2002) in southwestern Wyoming, just north of Kemmerer Wyoming. Between 2002 and 2009, during which conducted intensive raptor migration counts daily from August 27 through November 5, the annual mean over the eight years was 3,665 raptors migrating over the ridge (Mika and Hawks 2011). In 2010, researchers reported 5,602 migrant raptors of 17 species. Almost two-thirds of the raptors were Golden Eagles. In light of this information, it is unclear why the DEIS states that the project "would not have a measureable adverse effect on migratory bird populations or significant bird conservation sites" (DEIS p. 2-208.), especially as HWI has documented raptors using the entire north-south ridgeline of Commissary Ridge as a migration corridor. Furthermore, the DEIS fails to discuss raptor migration passage volume , use of the entire north-south ridgeline for migration, or collision risk associated with the proposed line crossing the ridge perpendicular to this migration pathway (DEIS 3.10-16).

The abundance of raptors species in the area becomes problematic in that the presence of transmission lines and **towers greatly increase perching and nesting**. As noted in the DEIS (page 3.11-57), the potential increase in raptor and raven numbers along the transmission route could result in an increase

in harassment and predation rates on prey species (including sage-grouse, white-tailed prairie dogs, ground squirrels, rabbits, black-footed ferrets and a wide array of small mammals and birds). The DEIS further predicts that the effect of increased predation would be most pronounced in areas where there are not existing vertical structures (transmission lines, trees), which is approximately 64% of the route, as the transmission poles would provide new nesting and perching opportunities. Increased perching opportunities also increases potential for raptor electrocution. We strongly recommend against the use of traditional lattice tower structures as these increase perching and nesting opportunities (Engel et al. 1992, Steenhof et al. 1993). Instead, single steel pole structures should be used to the greatest extent possible as these reduce raptor perching threats to a wide variety of BLM species of concern (pygmy rabbits, burrowing owl, sage-thrasher, Brewer's sparrow, and sage-grouse). Where H-frame structures are used, we support the use of perch deterrents (DEIS TESWL-3).

The DEIS contains a table with unreconciled lists of suggestions for raptor EPM's or mitigation measures from the proponent and from the BLM. Mitigation measures that provide the greatest conservation value or are based on the most recent scientific information pertinent to individual species and their habitats should be chosen for each species, and must be published with a period for public comment. Generally, **mitigation measures** should at least equal those found in USFWS "Draft Guidelines for Raptor Conservation in the Western United States" (Whittington and Allen 2008).

While the DEIS acknowledges concern with perching on **lattice towers**, the DEIS continues to present the whole project as being built with lattice towers. In the FEIS, the proponents should change the design of the structures and include **perch deterrents**, not only at water crossings but also in areas of potential migration corridors (such as Commissary Ridge).

B. <u>Ferruginous Hawk</u> (*Buteo regalis*)

According to the Wyoming Natural Diversity Database Species Assessment of the Ferruginous hawk (Travsky and Beauvais 2005):

> Among the many species of raptors occupying portions of the proposed and alternative routes is the Ferruginous hawk, a Bureau of Land Management Sensitive Species. These mostly ground nesting birds are highly sensitive to human disturbances.
>
> The ferruginous hawk occupies arid and open grassland, shrubsteppe, and desert in the western half of North America. It is the largest hawk in North America, with wingspans up to 1.5m and body mass >2kg. Breeding occurs from Alberta, Manitoba, and Saskatchewan south to New Mexico and Arizona, west to eastern California and Oregon, and east into the Dakotas, Nebraska, and Kansas. Primary wintering grounds are in the southwestern U.S. and northern Mexico. Ferruginous hawks breed across a large portion of Wyoming, and some individuals winter in the state as well.
>
> The ferruginous hawk was petitioned, and denied, for listing under the federal Endangered Species Act in 1991. Although not officially designated Threatened or Endangered, this species

is generally accepted to be declining rangewide (Bechard1981, Houston and Bechard 1984, Woffinden and Murphy 1989, Ure et al. 1991). Wyoming populations may be stable to increasing, and the state appears to support a relatively large amount of suitable habitat under current conditions.

Viable populations of ferruginous hawks depend on large expanses of native grass and shrubs that support abundant prairie dogs (*Cynomys* spp.), other ground squirrels, and jackrabbits (*Lepus townsendii, L. californicus*), and with minimal human activities and disturbances during the breeding season.

Knowledge to-date suggests that the major limit to ferruginous hawks is not high mortality, but instead low reproductive output as caused by habitat loss to cultivation and cheatgrass (*Bromus tectorum*) invasion, reduced distribution and abundance of prey (especially prairie dogs), and locally-high (and probably increasing) levels of disturbance to nesting pairs.

Since raptors are known to concentrate along **ridge tops, upwind sides of slopes, and canyons** to take advantage of wind currents that are favorable for hunting and traveling, as well as for migratory flights, **these locations should be avoided when siting the transmission line**. In addition, known **raptor nests** should be avoided in consultation with USFWS and state fish and game agencies. Where feasible, **underground lines** will minimize impacts.

C. <u>Golden Eagles</u> (*Aquila chrysaetos*)

Based on the USFWS' analysis of populations across the nation, there is no safe allowable take level for Golden Eagles; however, take is likely unavoidable with transmission project of this magnitude and in this location. Use by Golden Eagles is not surprising as the application area contains native shrubland and grassland communities, as well as natural landscape features, that provide foraging and nesting opportunities sought by Golden Eagles. Given the growing concern for these majestic birds, especially related to mortalities associated with wind farms and expanding transmission infrastructure, any development decisions that will impact Golden Eagles must be placed within a regional population context much larger than the area immediately surrounding any proposed transmission project, which this DEIS fails to do.

The status of the Golden Eagle is so dire that the USFWS currently authorizes take permits only under the philosophy that **"no net loss"** may be attributable to such take. Raptor migration counts and Christmas Bird Counts have indicated a **decline in Golden Eagle populations** in western North America since the 1980s, especially in recent decades (Farmer et al. 2007). Similarly, a recent update of this data continues to suggest juvenile eagles are declining in some regions (Neilson et al. 2010). In February 2011, the USFWS issued the Draft Eagle Conservation Plan Guidance ('Guidance'). The Guidance is intended to assist project developers and USFWS personnel in actions to avoid, minimize, restore and compensate adverse effects to Bald and Golden Eagles, describing a process by which project developers can collect and analyze information that could lead to programmatic permits authorizing additional take of eagles. The Guidance is designed to comply with the regulatory

requirements of the Bald and Golden Eagle Protection Act (BGEPA) and is intended to be consistent with the statutory definitions and requirements therein[9]. When finalized, the new eagle guidance will provide a mechanism where the USFWS may legally authorize the non-purposeful take of eagles, but the draft suggests that this will occur only when the take is "consistent with the goal of stable or increasing breeding populations." In this case, the USFWS' stated preference for avoidance over compensatory mitigation is most appropriate. Again, we are left with a situation where the proposed project is proceeding ahead of guidance and data necessary to ensure that significant wildlife values are not compromised**. We recommend that BLM fully ensures compliance with BGEPA and ensures stable or increasing Golden Eagle breeding populations** – an action that has not been adequately addressed in the DEIS.

Without project modification, the proposed **site appears inconsistent with the USFWS' goals of minimizing eagle population impacts** and avoidance over compensatory mitigation. Improvements can be achieved by using historical and current survey data, as well as the Key Raptor Areas, to identify areas to avoid development. One such area are migration routes, which received very minimal attention in the DEIS (not even mentioned as a concern in Section 2). Areas out 10 miles from the application area should be evaluated. Adequate buffers should be in place and monitored to evaluate effectiveness. Compensatory mitigation for retrofitting of lethal power poles in the region should be considered for the first five years of operation. In addition, the Eagle Conservation Plan should include Advanced Conservation Practices to reduce risks to Golden Eagles and other raptors from the project (Appendix A).

To further ensure adequate protections, science-based **Regional Conservation Plans** for Golden Eagles should be developed. As part of this effort, area-specific risk assessment information should be used to establish risk-zones—paralleling the risk categories described in the Guidance, but assessing landscape-level conditions. This would be a logical extension of the risk categorization framework delineated in the Guidance and would create a management tool more consistent with the population-level obligations imposed by BGEPA. Given the definition of take and disturbance under BGEPA, site assessments must examine project impacts on eagle foraging habitat, nesting, roosting sites, wintering habitat, migratory stopover sites, migratory corridors, and defended eagle territories. In order to comply with USFWS regulations, BLM must ensure additional analysis and data collection are

[9] The Bald and Golden Eagle Protection Act (BGEPA), 16 U.S.C. §§ 668 *et seq*., is intended to be the "primary vehicle" for the conservation and protection of Golden Eagles (*see* 71 Fed. Reg. 8265, 8266 (Feb. 16, 2006)), and as such, makes it unlawful to "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or in any manner, any bald eagle [or Golden Eagle] alive or dead, or any part, nest, or egg thereof . . .." (16 U.S.C. § 668(a)). Principal among the Act's protections, the prohibition against "take," by definition, makes it illegal to "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or *disturb*" an eagle (50 C.F.R. § 22.3 (2010) (emphasis added)). Further, "disturb means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available: (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior" (50 C.F.R. § 22.3 (2010)).

conducted within the project boundaries and the resultant information provided to interested parties consistent with NEPA's requirements.

Given the **uncertain status of populations** and their documented conflict with transmission lines, the opportunity should be taken to conduct **research** on Golden Eagles utilizing the project area, potentially part of a regional eagle population study. This would provide extremely valuable information on the population, habitat use, and possible displacement impacts.

IX. TES Plants

As with wildlife species discussed above, we are concerned that BLM uphold its FLPMA responsibilities, publish adequate information for analysis and public comment on the impacts to plant species and recommended mitigations, and create an effective monitoring and adaptive management plan for the life of the project.

- ***Recommendation:*** We recommend Section 7 conferencing with USFWS for all candidate plant species.

X. Visual Impacts

Construction of new transmission facilities and related infrastructure, particularly in relatively undisturbed or pristine areas, has the potential to significantly impact visual and scenic resources, and therefore we request that careful attention be given to this important issue. Indeed, due to the large number of transmission and wind development projects proposed in Wyoming and other states along the proposed route (e.g., *see* http://wyia.org/projects/transmission-projects/), the potential exists for landscape-altering impacts to occur over thousands of acres of the public lands.

Full disclosure of these impacts as well as options to mitigate them must be discussed in the FEIS. *See* 40 CFR 1502.14(f) ("include appropriate mitigation measures not already included in the proposed action or alternatives") and 40 CFR 1502.16(h) (environmental consequences section shall include discussions of "means to mitigate environmental impacts"). As a general principle, however, the Conservation Groups urge BLM to prioritize protection of habitat and biological resources over visual impacts – subject to case-by-case balancing of the relative impacts of various alternatives.

FLPMA directs that the public lands be managed in a manner that will protect the quality of scenic resources. 43 USC 1701(a)(8) (emphasis added). Thus, in addition to the disclosure mandated by NEPA, BLM has an affirmative duty to design and locate any new transmission facility in a manner that protects scenic resources. For federal lands, the duty to protect scenic resources is generally satisfied by meeting the RMP's visual resource management objectives. Accordingly, the FEIS should carefully examine options and methods to 1) avoid impacts altogether (40 CFR 1508.20(a)), and, if avoidance is not possible, 2) minimize impacts to visual and aesthetic resources (40 CFR 1508.20(b)) to a degree and extent that meets the applicable visual resource management objective for the area. In

some instances protecting visual impacts will have to be balanced against impacts to other resources that could be impacted by an alternative route.

The most obvious way to avoid impacts to scenic resources on the public lands is for BLM to deny Gateway West's ROW applications by adopting the no action alternative or, to selecting a different action alternative that satisfies the purpose and need in some other way, as addressed earlier in our comments.

However, should those other options to satisfy the purpose and need be deemed infeasible (we expect a thorough and scientifically credible explanation as to why), BLM must explore other methods to minimize impacts, including but not limited to: 1) alternate routes; 2) engineering, design and construction; 3) use of topography and terrain features to hide/conceal line segments and towers. The DEIS fails to discuss other types of towers that could be used that may lessen visual impacts, such as tubular V-string or guyed V-string (where guyed structures are appropriate). The DEIS also fails to discuss a) why towers need to be the proposed height when shorter towers may be less visible (and whether shorter towers can be employed for any sections of the proposed line), and b) lengthening the span between towers to reduce the overall number of towers.

Second, the FEIS should discuss options involving low glare and low visibility coatings and materials on all metal surfaces. Reflection of sunlight from towers and lines, particularly the hour or two following sunrise and again before sunset, can be seen for miles and often dominates the natural landscape. Therefore, the FEIS must address ways to mitigate this particular kind of significant impact.

Third, the FEIS should carefully examine on a site-specific segment-by-segment basis options to conceal or hide transmission lines and towers through use of natural topography and terrain features while avoiding habitat fragmentation.

- ***Recommendation***: Visual impact mitigation options should be fully analyzed and required, based on consultation with other agencies, local communities, and the public.

XI. Public Education, Engagement, and Outreach

We realize the tremendous challenge of engaging communities and other stakeholders along the 1000-plus mile proposed corridor. Engagement with conservation groups, other NGOs, communities and other stakeholders should continue throughout the planning process.

First, continuing a comprehensive outreach program will provide the public with a clearer understanding of the route alternatives under consideration, and of how the project may contribute to a cleaner grid. This program should specifically address (1) how the proposed transmission line fits into a broader set of plans for renewable energy development and transmission in the West; (2) the extent to which the line will incorporate renewable energy and contribute to greener grid; and (3) the extent to

which the permitting process can result in decisions that avoid development of redundant, excess or duplicative transmission infrastructure.

Continuing the dialogue as the FEIS is developed could provide constructive suggestions to minimize conflicts over route selection, project design, and mitigation activities. This process would build on ongoing discussions with public, private and NGO stakeholders. An ongoing process that could be used as a model is the MSTI Review Project, as seen in Exhibit 6.

- ***Recommendation***: BLM should work with the proponent to move beyond the stakeholder process as conducted so far, and support an independent review process such as the MSTI Review Project.

XII. Detailed Construction, Operations, and Maintenance Plans

Inclusion of a detailed COM plan will be extremely important to allow the public to fully understand, analyze and provide substantive comments on the EIS.

- The FEIS should fully analyze construction, operation and maintenance (COM) issues by addressing the following questions:
- If the route is shared with other transmission lines or similar infrastructure, what can be done to minimize the total width of the routes, especially in sensitive areas?
- What is the plan for vegetative management below and near the line? Minimizing such management is best for habitat and ecosystem values.
- What is the construction and maintenance plan for planned access roads to service the line?
- What measures can be taken to minimize and mitigate the impacts of these roads, including prevention of unauthorized use?
- What is the efficacy of anti-roosting devices to discourage raptor perching, and what can be done to employ the most effective technologies?
- How will communication systems (including mobile radio systems) and regeneration sites be sited to avoid, minimize and mitigate impacts?
- Where are ground electrode facilities planned for each terminal?

- ***Recommendation*:** BLM should include a detailed COM plan in the FEIS.

XIII. Alternative Technologies and Design Features

Transmission technology continues to improve, as do examples of successful implementation of new techniques to minimize impacts. These include but are not limited to undergrounding lines, advanced tower designs, using double circuits on compact monopoles and performing tower installation and maintenance with helicopters. Though these advanced approaches can increase technical and economic challenges for projects, they will only become more important to consider as transmission siting continues to grow more difficult and contentious.

The FEIS should examine the option of line burial in areas identified in existing land use plans as visually sensitive and for other especially sensitive landscapes where burial would avoid or minimize the resource impacts of overhead lines. Existing special designations described in federal land management land use plans to protect scenic, visual, cultural and historic resources must be maintained and honored. For example, for any sections of the proposed line crossing particularly sensitive areas BLM should analyze both re-routing to avoid those areas, and burying the lines (where feasible, in or near existing ROWs) to lessen the impacts.

We appreciate that line burial is an expensive option, but widespread use of this technique in Europe suggests that it could be an option to mitigate impacts to sensitive resources. As such, we expect a full and scientifically credible analysis of this option in such areas. We have attached information to aid in the analysis of this particular mitigation tool. Exhibits 19, 20, 21, and 22.

Gateway West should consider using (and BLM should analyze requiring) underground lines where overhead ones seriously conflict with sensitive biological resources. Although we realize that cost is a major issue with underground lines, they could be used selectively to demonstrate their utility as a means to minimize impacts. Exhibit 19 is a summary of some current underground line technologies, existing deployment, and references to additional sources of information prepared by Mick Meader of the Cascabel Working Group as part of comments on the proposed SunZia transmission line. The FEIS should use this information to inform its analysis of potential use of underground lines for Gateway West.

As noted above, Exhibit 22 summarizes some current underground line technologies, existing deployment, and references to additional sources of information. We recommend that the BLM use this information to inform its analysis of potential use of underground lines for Gateway South. In addition, we have attached exhibits regarding the ABB Group's underground DC technology, HVDC Light, which appears to offer significant advantages over overhead lines. Exhibit 20. Recent and ongoing applications establish the viability of buried DC lines for long distances up to hundreds of kilometers. Exhibits 19 and 21.

- ***Recommendations***: BLM should analyze potential implementation of advanced technologies to minimize impacts in the FEIS, and where appropriate, require that they be used. The potential for burying lines in sensitive areas should be rigorously analyzed.

XIV. Cumulative Impacts Analysis

Under NEPA, the agency is required to consider cumulative impacts, which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable actions. 40 C.F.R. § 1508.7; *Lands Council v. Powell,* 395 F.3d 1019 (9th Cir. 2005)*; Klamath Siskiyou Wildlands Center v. BLM*, 387 F.3d 989, 993 (9th Cir. 2004).

As the Ninth Circuit has held, a cumulative effects analysis must contain "some quantified or detailed information" – hence, "[g]eneral statements about possible effects and some risk do not constitute a hard look absent a justification regarding why more definitive information could not be provided." *Klamath Siskiyou*, 387 F.3d at 994 (internal quotations omitted).

As the regulations state, "[c]umulative impacts can result from individually minor but collectively significant actions taking place over a period of time," and an agency must consider whether "the action is related to other actions with individually insignificant but cumulatively significant impacts." 40 C.F.R. §§ 1508.7, 1508.27(b)(7). In analyzing the cumulative effects of a proposed action, an agency must do more than just catalogue "relevant past projects in the area." *City of Carmel-by-the-Sea*, 123 F.3d at 1160. The EIS "must also include a 'useful analysis of the cumulative impacts of past, present and future projects.'" *Id*. This means a discussion and an analysis in sufficient detail to be "useful to a decisionmaker in deciding whether, or how, to alter the program to lessen cumulative impacts." *Id*. The cumulative impacts analysis for a proposed project must examine past, present, and proposed/reasonably foreseeable actions that have cumulatively significant impacts or are similar in timing or geography. 40 C.F.R. §§ 1508.7, 1508.25, 1508.27(b)(7); *Tomac v. Norton*, 433 F.3d 852, 864 (D.C. Cir. 2006).

A comprehensive cumulative impacts analysis is essential to inform the proper siting, design and operation of transmission projects. The FEIS should fully evaluate the potential cumulative impacts of all current, proposed and reasonably foreseeable projects that will impact the lands and resources traversed by the line. An initial list of other projects and activities that should be incorporated into the analysis includes[10]:

- Gateway South.
- Gateway Central.
- Wind farms and other energy development activity that could produce power to be carried by other proposed projects, whether in Wyoming or elsewhere, including the Chokecherry & Sierra Madre, Dry Creek, and Sand Creek Wind Energy Projects
- Plans and projections for a "IPP System" substation near Delta, Utah, including any energy generation and related infrastructure associated with such a station; and an analysis of how such component might influence the line's economics.
- Any thermal plants or other projects proposed to provide "firming" power for TransWest, Gateway West or other lines.
- The Overland Transmission Project, which would carry 3,000 megawatts of DC power an estimated 550 miles from eastern Wyoming to Idaho.
- The Zephyr, a 500KV DC line that would run from approximately Medicine Bow, Wyoming, to Las Vegas.
- Current transmission projects being proposed for Wyoming are enumerated and mapped at http://wyia.org/projects/. All of these projects are reasonable foreseeable.

[10] For Wyoming, plans to integrate natural gas and wind are discussed at http://wyia.org/newsworthy/wyoming-releases-study-of-a-collector-system-and-integration-of-wind-and-natural-gas-phase-2-study/

- Sigurd to Red Butte No. 2 - 345 kV Transmission Project, which would connect the Sigurd substation, located approximately six miles northeast of Richfield, Utah to the Red Butte substation, southwest of Central in Washington County, Utah.
- Mona to Oquirrh Transmission Project, a 500 kV and 345 kV alternating current line from Salt Lake City to Mona, Utah.
- One Nevada Transmission Project/SWIP South, a 500 kV AC line from Idaho to Las Vegas.
- Southern Nevada Intertie Project, a 500 kV AC line.
- TransCanada Corp.'s $3 billion Chinook line, proposed to carry as much as 3,000 megawatts of mostly wind-generated electricity from new and expanding wind farms in Montana to large population centers in Arizona, California and Nevada.
- Oil and gas leasing and development activity near the proposed route – in Wyoming, Colorado and Utah.
- Uranium or other mining leasing or mines.
- Wind, solar, geothermal or other renewable energy projects near the line, or under consideration in connection with other transmission proposals.

Several of the proposed transmission projects are depicted in Exhibit 23, a summary of Proposed Intermountain Transmission Projects compiled by Rocky Mountain Power.

For the projects and activities listed above, the FEIS should prepare comparative projected GHG emissions, and compile a table showing the potential GHG impacts of each project and the total across all projects. Such analysis should focus on 1) GHG emissions from generation sources; and 2) the emissions associated with the length and efficiency of the line. Given the importance of reducing the threats from climate change, this analysis is an important component of the FEIS. Based on this comparison and other information, the FEIS should discuss the redundancy perceived by most of the environmental community for some of these projects as well as which ones are most likely to satisfy economic, environmental or socio-economic expectations. Alternatively, BLM could perform this analysis independently and incorporate make the results available for public review in the FEIS.

For all the above projects and activities, the FEIS should analyze potential impacts and timing to provide a full picture of potential cumulative impacts. The comprehensive cumulative impacts analysis will contribute to informed decision-making as required by NEPA, and help inform appropriate mitigation measures, opportunity costs and larger picture decisions about the level of development that can be sustained by the environment and local communities.

PacifiCorp is currently engaged in an Integrated Resource Planning (IRP) process[11]. Implementing the decisions made as a result of the IRP process regarding the company's future resource mix will contribute directly to the cumulative impacts of Gateway South and other PacifiCorp transmission lines. Western Resource Advocates' March 2011 comments on the Draft 2011 IRP are attached as Exhibit 24. Although the current Draft IRP does not propose any new or expanded coal generation, PacifiCorp indicates a continuing reliance on fossil fuels.

[11] http://www.pacificorp.com/es/irp.html

Thus, we urge that a more proactive approach to climate change on the part of PacifiCorp must include a significantly stronger and more consistent commitment to energy efficiency and renewable energy, emphasizing renewable distributed generation resources – to achieve reductions in greenhouse gas emissions, and renewable energy. Most of the Conservation Groups would be opposed to any proposals to build new or expanded coal generation -- without effective carbon capture and sequestration -- in conjunction with Gateway West, and to permitting a new transmission line that would carry power produced at such facilities.

In a June 13, 2011, statement, the White House recognized that "A 21st century grid is essential to America's ability to lead the world in clean energy and win the future[.]" Exhibit 25. The statement stressed the need "to modernize America's aging energy infrastructure and provide cleaner and more reliable power." The apparent future of Gateway West – carrying fossil-fuel based power, needs to be reconciled with the statements made in the fast-tracking announcement.

- ***Recommendation***: BLM should conduct a thorough cumulative impacts analysis for the DEIS, including an assessment of the quantity of additional CO2 emissions that could result from developing this line.

XV. Wildlands and Wilderness Characteristics

The line should avoid traversing or otherwise compromising potential wildlands.

We appreciate the BLM's acknowledgment of its obligations to inventory for and consider protecting lands with wilderness characteristics in the DEIS. Furthermore, we appreciate that the BLM conducted an inventory which includes lands over and above those identified by citizens and submitted to the BLM.

Section 201 of FLPMA mandates that BLM inventory the resources of the public lands, their resources and values. 43 U.S.C. § 1711. In the land use planning process, including revision of RMPs, Section 202 of FLPMA requires that BLM take into account the inventory and determine which multiple uses are best suited to which portions of the planning area. 43 U.S.C. § 1712. BLM's mandate of multiple use and sustained yield, as well as other relevant law and BLM's current guidance, provides for inventory and protection of wilderness values.

Wilderness character is a resource for which BLM must keep a current inventory. As the U.S. Court of Appeals for the Ninth Circuit recently held:

> …wilderness characteristics are among the 'resource and other values' of the public lands to be inventoried under § 1711. BLM's land use plans, which provide for the management of these resources and values, are, again, to "rely, to the extent it is available, on the inventory of the public lands, their resources, and other values." 43 U.S.C. § 1712(c)(4).

Oregon Natural Desert Ass'n v. Bureau of Land Management, 531 F.3d 1114, 1119 (9th Cir. 2008). Therefore, BLM is required to consider "whether, and to what extent, wilderness values are now present in the planning area outside of existing WSAs and, if so, how the Plan should treat land with such values." Id. at 1143.

BLM's current guidance on inventory and management of lands with wilderness characteristics, Instruction Memorandum (IM) 2011-154, reiterates the agency's obligations under FLPMA "to conduct and maintain inventories" and "to consider identified lands with wilderness characteristics in land use plans and when analyzing projects under the National Environmental Policy Act." IM 2011-154 was issued in July, 2011 and the FEIS approach to inventory and management of lands with wilderness characteristics should follow this guidance.

The National Environmental Policy Act (NEPA) dictates that the BLM take a "hard look" at the environmental consequences of a proposed action and the requisite environmental analysis "must be appropriate to the action in question." *Metcalf v. Daley*, 214 F.3d 1135, 1151 (9th Cir. 2000); *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 348 (1989). In evaluating the environmental consequences of a proposed action, NEPA directs the BLM to consider both beneficial and detrimental effects. 40 C.F.R. § 1508.8. Further, NEPA defines the types of effects that the agency must consider:

> Effects include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative." *Ibid*.

In addition, IM 2011-154 provides that BLM must "consider the benefits that may accrue to other resource values and uses as a result of protecting wilderness characteristics."

In making decisions about potential wilderness lands, BLM should recognize the wide range of multiple use and renewable resource values associated with wilderness characteristics:

- <u>Scenic values</u> – FLPMA specifically identifies "scenic values" as a resource of BLM lands for purposes of inventory and management. 43 U.S.C. § 1711(a).
- <u>Recreation</u> – FLPMA also identifies "outdoor recreation" as a valuable resource to be inventoried and managed by BLM. 43 U.S.C. § 1711(a).
- <u>Wildlife habitat and ecosystem health</u> – FLPMA acknowledges the value of wildlife habitat found in public lands and recognizes habitat as an important use. 43 U.S.C. § 1702(c). Undeveloped landscapes also provide clean air, clean water and lack of disturbance necessary for healthy habitat and ecosystems.
- <u>Cultural resources</u> – FLPMA recognizes the importance of "historical values" as part of the resources of the public lands to be protected. 43 U.S.C. § 1702(c). Other applicable laws include the Antiquities Act, the National Historic Preservation Act, and the American Indian Religious Freedom Act. Cultural resources, including those located outside of the proposed right-of-way that may experience visual or auditory impacts, should be identified as early as possible in the planning process, through additional surveys and consultation with tribal and other parties as appropriate. Consultation with Tribes and outreach to tribal members who use sacred sites and Traditional Cultural Properties are essential to identifying these landscapes. This should include field visits with cultural resource representatives and tribal elders. Cultural

resources include sites that are eligible for or listed in the National Register of Historic Places, Native American sacred sites, traditional cultural properties, and other lands with cultural values such as uses for plant collection or other subsistence and traditional activities. Once identified, BLM must evaluate the full range of impacts—direct, indirect and cumulative—on cultural resources, including visual and auditory impacts when setting contributes to the historic significance of a site. Avoidance is the preferred management approach for cultural, sacred, historic, and archaeological sites.

- Economic benefits – The recreation opportunities provided by wilderness quality lands and outdoor recreation yield direct economic benefits to local communities. According to the U.S. Fish and Wildlife Service, in 2006 State residents and non-residents spent $1.1 billion on wildlife recreation in Wyoming. Local communities that protect wildlands reap measurable benefits in terms of employment and personal income.[12]
- Quality of life – Wildlands are an important component of the quality of life for local residents and future generations. Their protection enables the customs and culture of these communities to continue.
- Balanced use – The vast majority of BLM lands are open to motorized use and development. FLPMA recognizes that "multiple use" of the public lands requires "a combination of balanced and diverse resource uses" that includes recreation, watershed, wildlife, fish, and natural scenic and historical values (43 U.S.C. § 1702(c)).

- ***Recommendations***: In accordance with Secretarial Order 3310, BLM IM 2011-154, and new BLM Manuals 6301, 6302, and 6303, the project should avoid adversely impacting wilderness resources. Project analysis should highlight the important socioeconomic values of managing these lands for their wilderness characteristics.

XVI. Socioeconomic and Cost-benefits Analysis

The FEIS must provide a comprehensive socioeconomic and cost-benefits analysis. The economic analysis of this estimated $1.5 billion project is a critical concern. As recommended below, the FEIS should fully examine the costs and benefits using the total economic value approach. It should calculate the total cost per KWH of electricity delivered, and compare that figure to the cost of renewable generation in the built environment close to the point of use. Jobs and ancillary economic magnifiers related to the project should also be considered.

The Gateway West EIS is a critical opportunity to evaluate impacts to non-market values of public lands from the imposition of industrial infrastructure. A comprehensive socio-economic analysis should address natural values and resources. The paper entitled "Socio-Economic Framework for Public Land Management Planning: Indicators for the West's Economy" details expectations for the baseline analysis of the affected economies as well as the analysis of the potential impacts of potential

[12] *See* USFWS 2006, *National Survey of Hunting, Fishing and Wildlife-associated Recreation* - http://www.census.gov/prod/2008pubs/fhw06-wy.pdf; Sonoran Institute 2004, *Prosperity in the 21st Century West -The Role of Protected Public Lands*. Additional studies include Morton 2000, *Wilderness: The Silent Engine of the West's Economy;* Morton 1999, *The Economic Benefits of Wilderness: Theory and Practice*; and Loomis 2000, *Economic Values of Wilderness Recreation and Passive Use: What We Think We Know at the Turn of the 21st Century*.

decisions on the proposed project. Exhibit 26 (including The Wilderness Society report, Natural Dividends: Wildland Protection and the Changing Economy of the Rocky Mountain West) Exhibit 27. We also recommend the approach of Navrud et al (2008) for quantifying the impact of linear infrastructure on use or nonuse values to public lands.

We recommend that the BLM use a "total economic value" approach that includes estimates of non-market values for the wildlands and open spaces in the planning area. BLM recently affirmed its commitment to this approach in draft IM 2010-061, which explicitly directs managers to evaluate non-market values in EIS analyses. The total economic value analysis should include the full range of non-market values, including use values – such as recreation – as well as non-use values such as existence value (the benefit one gains just knowing wildlands are protected), option values (the benefit of knowing that one can visit a wildland for recreation) and bequest values (the benefit gained from knowing that wildlands are protected for future generations).

The benefits that flow from protected wildlands and healthy ecosystems are important economic drivers in many rural areas. Scenic vistas and recreational opportunities make communities attractive to businesses and employees seeking the highest quality of life. Wildlands in rural Western counties are correlated with income, employment, and population growth (Lorah 2000). They increase nearby property values for home owners and generate recreation and tourism dollars. Undeveloped landscapes provide vital natural services such as intact habitat, filtering our drinking water, and increasing the ability of wildlife to adapt to and weather climate change.

One of the most important purposes of public lands is providing non-market public goods such as opportunities for solitude, outdoor recreation, clean air, clean water, biodiversity, the preservation of wilderness and other undeveloped areas – which could be lost if left entirely to market forces (Loomis 1993). FLPMA specifically incorporates such non-market resources as "the long-term needs of future generations" for recreation and "natural scenic, scientific and historical values" into the BLM's multiple use mandate. 43 U.S.C. § 1702(c). This FLPMA section further defines multiple use to require the agency to encompass non-market values into management, directing the BLM to achieve:

> "harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or the greatest unit output."

Resource economists recognize that some public goods and services produced by public land have characteristics that make them unprofitable to private enterprises. Protected public lands perform natural services worth billions of dollars. These lands provide a wide range of vital ecosystem services and contribute to the biodiversity that sustains life.

- ***Recommendations***: The FEIS should evaluate non-market values provided by wildlands, undeveloped landscapes, and other natural values and ecosystem functions. The total economic value approach should be incorporated.

XVII. Availability of GIS data

Significant GIS data is being gathered as part of the EIS process for Gateway West. Public access to this data is needed to assist the public in understanding, analyzing and making substantive comments on the proposed project. BLM should provide the data for download on the project website, following the model set by other BLM NEPA processes -- including the Solar Programmatic EIS (PEIS), Geothermal PEIS, and West-wide Energy Corridors PEIS, as well as the Western Governors' Association Western Renewable Energy Zone Project. We appreciate the data BLM has made available to date.

XVIII. Conclusion

Thank you for your thorough consideration of these comments. Please do not hesitate to contact us with any questions or requests for clarification or additional information. We look forward to participating in future planning processes for this project, which we understand will also include stakeholder siting resolution meetings.

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Exhibit 1: State of Wyoming Executive Order 2011-5: Greater Sage-Grouse Core Area Protection. http://gf.state.wy.us/wildlife/wildlife_management/sagegrouse/Sage_Grouse_EO_2011_5.pdf

Exhibit 2: Conservation Plan for the Greater Sage-grouse in Idaho (2006) http://fishandgame.idaho.gov/public/wildlife/sageGrouse/conservPlan.pdf

Exhibit 3: Framework for Mitigation of Impacts from Infrastructure Projects on Sage-grouse and Their Habitats (supplement to the *Conservation Plan for Greater Sage-grouse in Idaho*). Idaho Sage-Grouse Advisory Committee. December 2010.

Exhibit 4: USFWS Endangered Species Incidental Take Permit (New Mexico)

Exhibit 5: Wyoming Game and Fish Department Identified Species of Greatest Conservation Need, State Wildlife Action Plan (2010) http://gf.state.wy.us/downloads/pdf/SWAP/2010%20SWAP%20Species%20of%20Greatest%20Conservation%20Need%20Introduction.pdf

Exhibit 6: MSTI Review Project. PowerPoint Presentation. September 2011.

Exhibit 7: Map of Gateway West routes in relation to regional sage-grouse breeding densities in Idaho and Wyoming. (data source: Doherty et al. 2010)

Exhibit 8: USFWS Endangered Species Summary: Greater Sage-Grouse http://www.fws.gov/mountain-prairie/species/birds/sagegrouse/

Exhibit 9: Prairie grouse leks and wind turbines: U.S. Fish and Wildlife Service justification for a 5-mile buffer from leks; additional grassland songbird recommendations. Manville, A.M., II (2004). Division of Migratory Bird Management, USFWS, Arlington, VA, peer-reviewed briefing paper. http://www.environment.ok.gov/documents/OKWindEnergy/PrairieGrouseLeksWindTurbines.pdf

Exhibit 10: Wildlife Protection Recommendations for Wind Energy Development, Wyoming Game & Fish Department (2010). http://gf.state.wy.us/downloads/pdf/Final%20WGFC%20Approved%20Wind%20Recommendations%2011-17-10.pdf

Exhibit 11: Western Association of Fish and Wildlife Agencies (WAFWA) letter to Fish and Wildlife Service re: precarious stat of Greater Sage-grouse, need for short-term regulation, long-term habitat restoration (June 21, 2011)

Exhibit 12: USFWS 12-Month Findings for Petitions to List the Greater Sage-Grouse (*Centrocercus urophasianus*) as Threatened or Endangered. 50 CFR Part 17, [FWS-R6-ES-2010-0018], [MO 92210-0-0008-B2] http://www.gpo.gov/fdsys/pkg/FR-2010-03-23/pdf/2010-5132.pdf (hard copy excerpted)

Exhibit 13: Bureau of Land Management Instruction Memorandum No. 2010-071: Gunnison and Greater Sage-grouse Management Considerations for Energy Development (Supplement to *National Sage-Grouse Habitat Conservation Strategy*). 2010.

Exhibit 14 USFWS letter to State of Wyoming re: Greater Sage Grouse (Nov. 10, 2010).

Exhibit 15: Utah Division of Wildlife Resources, Wildlife Notebook Series No. 17. http://wildlife.utah.gov/publications/pdf/2010_sharp-tailed_grouse.pdf

Exhibit 16: Columbian Sharp-tailed Grouse (*Tympanuchus phasianellus columbianus*): a technical conservation assessment. Hoffman, R.W. and A.E. Thomas. (August 17, 2007). USDA Forest Service, Rocky Mountain Region. http://www.fs.fed.us/r2/projects/scp/assessments/columbiansharptailedgrouse

Exhibit 17: Guidelines for management of Columbian Sharp-tailed Grouse habitats, Giesen, K. M., and J. W. Connelly (1993). Wildlife Society Bulletin 21:325-333. http://www4.ncsu.edu/~csdepern/documents/10-Giesen.pdf

Exhibit 18: Protection of Wildlife Resources: 1200 series, Wildlife of the Colorado Oil and Gas Conservation Commission rules.

Exhibit 19: Mitigation Strategies – Undergrounding of Transmission Lines (Mick Meader, Cascabel Working Group, May 16, 2010)

Exhibit 20: Underground High Voltage Cables: Wiring Europe for the Future**,** http://www.leonardo-energy.org/drupal/book/export/html/868

Exhibit 21: DC is the key to an integrated European power network (ABB paper), http://www02.abb.com/global/abbzh/abbzh250.nsf/0/de0cf0a395732cdfc12575ee0048b3de/$file/HVDC+-+European+grid.pdf

Exhibit 22: ABB celebrates landmark power technology (Nov. 19, 2009), http://www.abb.com/cawp/seitp202/09af930fd267b278c125767200450180.aspx

Exhibit 23: Map of Potential High Voltage Transmission Line Projects in the Western United States (prepared for BLM - March 10, 2009)

Exhibit 24: WRA Comments on Draft 2011 IRP (March 2011)

Exhibit 25: White House Grid Modernization Policies for a Clean Energy Economy (June 13, 2011)

Exhibit 26: Socio-Economic Framework for Public Land Management Planning: Indicators for the West's Economy (TWS 2006)

Exhibit 27: Natural Dividends: Wildland Protection and the Changing Economy of the Rocky Mountain West (TWS 2010)

Appendix A: Advanced Conservation Practices (Eagles)

Source: This information includes modified concepts originally introduced in the *draft* Golden Eagle Conservation Plan for the Ocotillo Wind Energy Facility (March 4, 2011), Imperial County, California. http://icpds.com/CMS/Media/DRAFT_Ocotillo_ECP_4_3_2011.pdf

Pre-Construction

- The area and intensity of disturbances are minimized during pre-construction monitoring and testing activities.
- Existing roads and transmission corridors are used to the extent possible while developing site plans.
- Structures are sited away from high avian use areas and the flight zones between them.
- The Avian Power Line Interaction Committee (APLIC) guidance on power line siting (APLIC 2006) is followed while planning.
- Site plans minimize the extent of the road network needed.
- No lattice or structures that are attractive to birds for perching are including in facility designs. Single steel pole structures should be used to the greatest extent possible.
- Lighting plans for the facility are the minimum according to requirements.
- All security lighting is motion or heat activated, instead of being left on throughout the night.
- All security lighting is down-shield and related to infrastructure lights.
- Structures are not sited in areas where eagle prey species are abundant.
- The facility is not sited in any areas containing high concentrations of ponds, streams, or wetlands.
- Perch deterrents are used along water crossings and where there is potential for migration corridors.
- Pre-construction surveys are conducted to identify habitat use and determine measures to avoid or minimize impacts, including locations for collision risk.

During Construction

- The area and intensity of disturbance are minimized to the extent possible during construction.
- Existing roads are used for access during construction to the extent possible.
- Powerlines are buried to the extent possible to reduce avian collision and electrocution.
- The Avian Power Line Interaction Committee (APLIC) guidance on power line construction (APLIC 2006) is followed.
- A transportation plan is implemented during construction that includes road design, locations and speed limits to minimize habitat fragmentation and wildlife collisions, and minimize noise effects. This will help to minimize carrion availability for golden eagles.
- Spatial and seasonal buffers is implemented to protect individual nest sites/territories and/or roost sites during construction, such as maintaining a buffer between activities and nests/communal roost sites and keeping natural areas between the project footprint and the nest site or communal roost by avoiding disturbance to natural landscapes.
- Human activity will be prohibited within line of site of nesting eagles to minimize disturbance.

During Operation

- Management activities such as seeding forbs or maintaining rock piles that attract potential prey are avoided.
- Parts and equipment which may be used as cover by prey are not stored in the vicinity of wind turbines.
- Any carcasses (with the exception carcasses being used for post-construction bias trials) found within the development area are removed immediately assuming the appropriate permits/authorizations have been granted to the proponent.
- Responsible livestock husbandry will be practiced (e.g. removal of carcasses, fencing, calving/lambing operations will not occur in the vicinity of the wind turbines).
- Low level speed limits (< 25 mph) are maintained on all roads
- Personnel are trained to be alert for wildlife at all times, especially during low visibility conditions.
- Personnel, contractors, and visitors are instructed to avoid disturbing wildlife, especially during the breeding seasons and seasonal periods of stress.
- Fire hazards are reduced from vehicles and human activities (e.g., use spark arrestors on power equipment, avoid driving vehicles off roads, and allow smoking in designated areas only).
- Federal and state measures for handling toxic substances are followed.
- Effects to wetlands and water resources are minimized by following provisions of the Clean Water Act (1972).
- Surveys should be conducted to determine actual mortality rates and allow for appropriate mitigation where able.

Additional ACPs

- Development of a long-term (> three years) eagle monitoring program for the transmission line.
- Modification and implementation of the curtailment strategies developed during the three years of post-construction monitoring, including consideration of possibly other technologies.
- Placement of visual and/or auditory bird flight diverters in critical locations.
- If fossorial mammals are found burrowing near structures, burrows may be filled and the immediate area may be surrounded with gravel at least two inches deep.
- Installing perch guards on overhead electric lines in the vicinity if eagles are shown to regularly use the lines.
- Golden eagles face threats from a variety of sources (disease, natural causes, poisoning, electrocution, power line collision, and other anthropomorphic causes), and supporting a rehabilitation center can save eagles.
- Identify highly disturbed nest sites in the region and promote and find ways to protect those nests from disturbance, which should lead to an increase in reproduction potential.
- Contribute funding for regional eagle population studies.

Appendix B: Advanced Conservation Practices (Terrestrial Wildlife)

This information includes a variety of practices to reduce direct and indirect impacts to terrestrial wildlife, including big game. We strongly encourage coordination with state game and fish department personnel and the U.S. Fish and Wildlife Service, to identify habitats of greatest importance. This information came from discussions with Wyoming Wildlife Federation, who will also be submitting comments on Gateway West DEIS.

- Employees should be required to participate in an Environmental Awareness Training Program. Trespass laws, laws on public lands, and current Wyoming Game and Fish regulations should be covered for the benefit of employees new to the area.
- Efforts should be made to bus construction crews to the work site to reduce overall vehicular traffic. This effort will reduce disturbance of wildlife in the area and reduce the risk of vehicle collisions with wildlife. Shuttles/busses should be used whenever possible to reduce vehicle traffic in the area. Vehicle traffic and increased human interaction can result in increased movement in mule deer and increased physiological stress (Mule Deer Working Group, 2010). Interactions should be minimized whenever possible.
- Reclamation of roads associated strictly with construction should begin immediately after completion of construction; reclamation being complete within five years.
- No construction activity should take place from November 15 – April 30 in big game crucial winter range to minimize impacts to wintering wildlife.
- The stipulations intended to protect wildlife need to be strictly enforced.
- Follow the Wyoming Game & Fish Department's Wind Recommendations 2010 (Exhibit 10)
- Establish an action plan for the potential loss of existing big game migration corridors.
- Vegetation monitoring should be part of the development and production phase. BLM must effectively protect habitats at risk from impacts associated with the proposed development.
- A baseline water quality monitoring and analysis plan must be developed. It should include a schedule for baseline surveys and data gathering prior to construction, during and after.
- All roads and project activities should be located as far from riparian and wetland communities as possible.
- Reclaim vegetation sites by using re-seeding techniques that promote non-invasive vegetation production.

MATTHEW H. MEAD
GOVERNOR

THE STATE OF WYOMING

STATE CAPITOL
CHEYENNE, WY 82002

Office of the Governor

STATE OF WYOMING
EXECUTIVE DEPARTMENT
EXECUTIVE ORDER

Order 2011-5
(Replaces 2010-4)

GREATER SAGE-GROUSE CORE AREA PROTECTION

WHEREAS, the Greater Sage-Grouse (Centrocercus urophasianus) inhabits much of the sagebrush-steppe habitat in Wyoming; and

WHEREAS, the sagebrush-steppe habitat type is abundant across the state of Wyoming; and

WHEREAS, the state of Wyoming currently enjoys robust populations of Greater Sage-Grouse; and

WHEREAS, the state of Wyoming has management authority over Greater Sage-Grouse populations in Wyoming; and

WHEREAS, the Greater Sage-Grouse has been the subject of several petitions to list the species as a threatened or endangered species pursuant to the Endangered Species Act; and

WHEREAS, the United States Department of the Interior has determined that listing the Greater Sage-Grouse as a threatened or endangered species is warranted over all of its range, including the populations in Wyoming; and

WHEREAS, the United States Department of the Interior has determined that listing the Greater Sage-Grouse as a threatened or endangered species is currently precluded by higher priority listing actions; and

WHEREAS, the Greater Sage-Grouse is currently considered a "candidate" species under the auspices of the Endangered Species Act; and

WHEREAS, the United States Department of the Interior is required to review the status of all candidate species every year; and

WHEREAS, the listing of the Greater Sage-Grouse would have a significant adverse effect on the economy of the state of Wyoming, including the ability to generate revenues from state lands; and

WHEREAS, the listing of the Greater Sage-Grouse would have a significant adverse effect on the custom and culture of the state of Wyoming; and

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WHEREAS, the Wyoming State Legislature and other agencies have dedicated significant state resources to conserve Greater Sage-Grouse populations in Wyoming; and

WHEREAS, the state of Wyoming has developed a "Core Population Area" strategy to weave the many on-going efforts to conserve the Greater Sage-Grouse in Wyoming into a statewide strategy; and

WHEREAS, members of the Sixtieth Legislature of the State of Wyoming signed a Joint Resolution recognizing "the Greater Sage Grouse Core Area Strategy [then embodied under Governor's Executive Order 2008-2] as the State of Wyoming's primary regulatory mechanism to conserve sage-grouse and preclude the need for listing the bird as a threatened or endangered species pursuant to the Endangered Species Act of 1973."; and

WHEREAS, on April 17, 2008, the Office of the Governor requested that the U.S. Fish and Wildlife Service review the "Core Population Area" strategy to determine if it was a "sound policy that should be moved forward" and on May 7, 2008, the U.S. Fish and Wildlife Service responded that the "core population area strategy, as outlined in the Implementation Team's correspondence to the Governor, is a sound framework for a policy by which to conserve greater sage-grouse in Wyoming"; and

WHEREAS, on November 10, 2010, the U.S. Fish and Wildlife Service again confirmed that "This long-term, science-based vision for the conservation of greater sage-grouse has set the stage for similar conservation efforts across the species range," and that "the Core Population Area Strategy for the greater sage-grouse provides an excellent model for meaningful conservation of sage-grouse is fully supported and implemented"; and

WHEREAS, several western states have adopted or are considering adopting the Wyoming Core Area Strategy, thus making the concept consistent across the species range; and

WHEREAS, new science, information and data continue to emerge regarding "Core Population Areas" and the habitats and behaviors of the Greater Sage-Grouse, which led the Governor's Sage-Grouse Implementation Team to re-evaluate the original "core population areas" and protective stipulations for Greater Sage-Grouse.

NOW, THEREFORE, pursuant to the authority vested in me by the Constitution and Laws of the State, and to the extent such actions are consistent with the statutory obligations and authority of each individual agency including those found in Title 9, Chapter 5, Article 3 of Wyoming State Statutes, otherwise cited as the Wyoming Regulatory Takings Act, I, Matthew H. Mead, Governor of the State of Wyoming, do hereby issue this Executive Order providing as follows:

1. Management by state agencies should focus on the maintenance and enhancement of Greater Sage-Grouse habitats, populations and connectivity areas identified in Attachment A. Absent substantial and compelling information, these Core Population Areas should not be altered for at least five (5) years.

2. Existing land uses within Core Population Areas should be recognized and respected by state agencies. It is assumed that activities existing in Core Population Areas prior to August 1, 2008 will not be managed under Core Population Area stipulations. Examples of existing activities include oil and gas, mining, agriculture, processing facilities, housing and other uses that were in place prior to the development of the Core Population Areas (prior to August 1, 2008). Provided these activities are within a defined project boundary (such as a recognized federal oil and gas unit, drilling and spacing unit, mine plan, subdivision plat, etc.) they should be allowed to continue within the existing boundary, even if the

use exceeds recommended stipulations (see Attachment B) recognizing that all applicable federal actions shall continue.

3. New development or land uses within Core Population Areas should be authorized or conducted only when it can be demonstrated that the activity will not cause declines in Greater Sage-Grouse populations.

4. Development consistent with the stipulations set forth in Attachment B shall be deemed sufficient to demonstrate that the activity will not cause declines in Greater Sage-Grouse populations.

5. Funding, assurances (including efforts to develop Candidate Conservation Agreements and Candidate Conservation Agreements with Assurances), habitat enhancement, reclamation efforts, mapping and other associated proactive efforts to assure viability of Greater Sage-Grouse in Wyoming should be focused and prioritized to take place in Core Population Areas.

6. To the greatest extent possible, a non-regulatory approach shall be used to influence management alternatives within Core Population Areas. Management alternatives should reflect unique localized conditions, including soils, vegetation, development type, predation, climate and other local realities.

7. For activities outside of Core Population Areas, no more than a one-quarter (1/4) mile no surface occupancy standard and a two (2) mile seasonal buffer should be applied to occupied leks. Incentives to enable development of all types outside Core Population Areas should be established (these should include stipulation waivers, enhanced permitting processes, density bonuses, and other incentives). Development scenarios should be designed and managed to maintain populations, habitats and essential migration routes where possible. It is recognized that some incentives may result in reduced numbers of sage-grouse outside of Core Population Areas.

8. Incentives to accelerate or enhance required reclamation in habitats adjacent to Core Population Areas should be developed, including but not limited to stipulation waivers, funding for enhanced reclamation, and other strategies. It is recognized that some incentives may result in reduced numbers of sage-grouse outside of the Core Population Areas.

9. Existing rights should be recognized and respected.

10. On-the-ground enhancements, monitoring, and ongoing planning relative to sage-grouse and sage-grouse habitat should be facilitated by sage-grouse local working groups whenever possible.

11. Fire suppression efforts in Core Population Areas should be emphasized, recognizing that other local, regional, and national suppression priorities may take precedent. However, public and firefighter safety remains the number one priority for all fire management activities.

12. State and federal agencies, including the U.S. Fish and Wildlife Service, Bureau of Land Management, U.S. Forest Service, and other federal agencies shall work collaboratively to ensure a uniform and consistent application of this Executive Order to maintain and enhance Greater Sage-Grouse habitats and populations.

13. State agencies shall work collaboratively with local governments and private landowners to maintain and enhance Greater Sage-Grouse habitats and populations in a manner consistent with this Executive Order.

14. It is critical that existing land uses and landowner activities continue to occur in core areas, particularly agricultural activities on private lands. For the most part, these activities on private lands are not subject to state agency review or approval. Only those activities occurring after August 1, 2008 which state agencies are required by state or federal statute to review or approve are subject to consistency review. This Executive Order in no way adds or expands the review or approval authority of any state agency. It is acknowledged that such land uses and activities could have localized impacts on Greater Sage-Grouse. To offset these impacts, Core Population Areas have been mapped to include additional habitat beyond that strictly necessary to prevent listing of the species. The additional habitat included within the Core Population Area boundaries is adequate to accommodate continuation of existing land uses and landowner activities. As a result, state agencies are not required to review most existing land uses and landowner activities in Core Population Areas for consistency with this Executive Order. Attachment C contains a list of existing land uses and landowner activities that do not require review for consistency.

15. It will be necessary to construct significant new transmission infrastructure to transport electricity generated in Wyoming to out-of-state load centers. New transmission lines constructed within Core Population Areas will be consistent with this Executive Order if they are constructed between July 1 and March 14 (or between July 1 and November 30 in winter concentration areas) and within one half (1/2) mile either side of existing (prior to Governor's Executive Order 2010-4) 115 kV or larger transmission lines creating a corridor no wider than one (1) mile. New transmission lines outside this one (1) mile wide corridor within Core Population Areas should be authorized or conducted only when it can be demonstrated that the activity will not cause declines in Greater Sage-Grouse populations.

16. For purposes of consistency with this Executive Order there is established a transmission line corridor through Core Population Areas in south central and southwestern Wyoming as illustrated on Attachment D. This two (2) mile wide corridor represents the state of Wyoming's preferred alternative for routing transmission lines across the southern portion of the state while reducing impacts to Core Population Areas and other natural resources. New transmission lines constructed within this corridor shall be considered consistent with this Executive Order if construction occurs within the corridor between July 1 and March 14 (or between July 1 and November 30 in winter concentration areas).

17. New distribution, gathering, and transmission lines sited outside established corridors within Core Population Areas should be authorized or conducted only when it can be demonstrated by the state agency that the activity will not cause declines in Greater Sage-Grouse populations.

18. State agencies shall strive to maintain consistency with the items outlined in this Executive Order, but it should be recognized that adjustments to the stipulations may be necessary based upon local conditions and limitations. The goal is to minimize future disturbance by co-locating proposed disturbances within areas already disturbed or naturally unsuitable.

19. The protective stipulations outlined in this Executive Order should be reevaluated on a continuous basis and at a minimum annually, as new science, information and data emerge regarding Core Population Areas and the habitats and behaviors of the Greater Sage-Grouse.

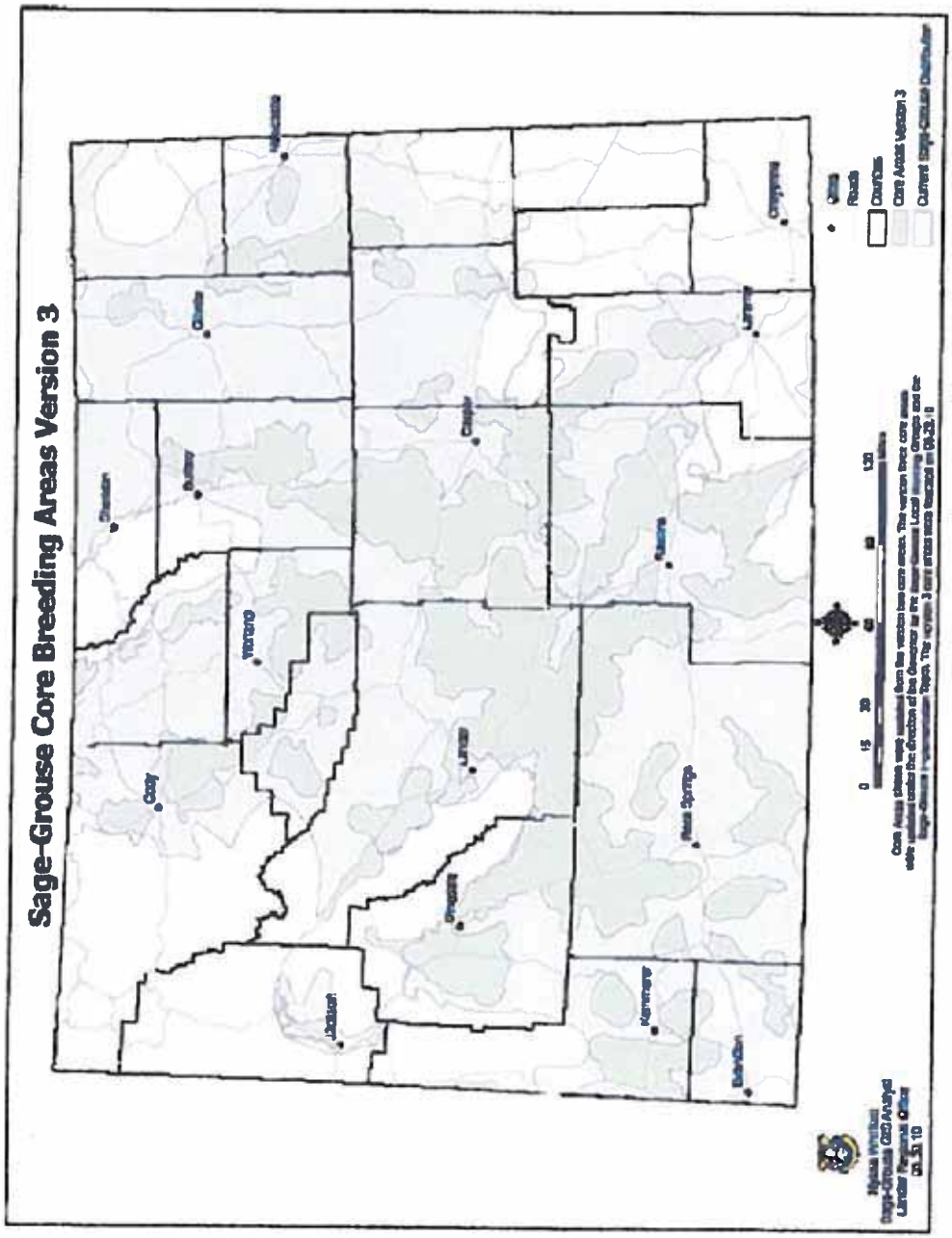
20. State agencies shall report to the Office of the Governor within ninety (90) days of signing and annually thereafter detailing their actions to comply with this Executive Order.

This Executive Order shall remain in effect until August 18, 2015, at which time all provisions of this Executive Order shall be reevaluated.

Given under my hand and the Executive Seal of the State of Wyoming this 2 day of June, 2011.

Matthew H. Mead
Governor

ATTACHMENT A



ATTACHMENT B

Permitting Process and Stipulations for Development in Sage-Grouse Core Areas

PERMITTING PROCESS

Point of Contact: The first point of contact for addressing sage-grouse issues for any state permit application should be the Wyoming Game and Fish Department (WGFD). Project proponents (proponents) need to have a thorough description of their project and identify the potential effects on sage-grouse prior to submitting an application to the permitting agency (details such as a draft project implementation area analysis, habitat maps and any other information will help to expedite the project). Project proponents should contact WGFD at least 45-60 days prior to submitting their application. More complex projects will require more time. It is understood that WGFD has a role of consultation, recommendation, and facilitation, and has no authority to either approve or deny the project. The purpose of the initial consultation with the WGFD is to become familiar with the project proposal and ensure the project proponent understands recommended stipulations and stipulation implementation process.

Maximum Disturbance Process: All activities will be evaluated within the context of maximum allowable disturbance (disturbance percentages, location and number of disturbances) of suitable sage-grouse habitat (See Appendix 1 for definition of suitable sage-grouse habitat and disturbance of suitable sage-grouse habitat) within the area affected by the project. The maximum disturbance allowed will be analyzed via a Density/Disturbance Calculation Tool (DDCT) process conducted by the Federal Land Management Agency on federal Land and the project proponent on non-federal (private, state) land. Unsuitable habitat occurring within the project area will not be included in the disturbance cap calculations.

1. Density/Disturbance Calculation Tool (DDCT): Determine all occupied leks within a core population area that may be affected by the project by placing a 4 mile boundary around the project boundary (as defined by the proposed area of disturbance related to the project). All occupied leks located within the 4 mile boundary and within a core population area will be considered affected by the project.

   A four-mile boundary will then be placed around the perimeter of each affected lek. The core population area within the boundary of affected leks and the 4 mile boundary around the project boundary creates the DDCT for each individual project. Disturbance will be analyzed for the DDCT as a whole and for each individual affected lek within the DDCT. Any portion of the DDCT occurring outside of core area will be removed from the analysis.

   If there are no affected leks within the 4 mile boundary around the project boundary, the DDCT area will be that portion of the 4 mile project boundary within the core population area.

2. Disturbance analysis: Total disturbance acres within the DDCT will be determined through an evaluation (Appendix 1) of:

   a. Existing disturbance (sage-grouse habitat that is disturbed due to existing anthropogenic activity and wildfire).

b. Approved permits (that have approval for on the ground activity) not yet implemented.

3. Habitat Assessment:

a. A habitat assessment is not needed for the initial DDCT area provided that the entire DDCT area is considered suitable.
b. A habitat assessment should be conducted when the initial DDCT indicates proposed project will cause density/disturbance thresholds to be exceeded, to see whether siting opportunities exist within unsuitable or disturbed areas that would reduce density/disturbance effects.
c. When a habitat assessment is conducted it should create a baseline survey identifying:
   i. Suitable and unsuitable habitat within the DDCT area
   ii. Disturbed habitat within the DDCT area
   iii. Sage-grouse use of suitable habitat (seasonal, densities, etc.)
   iv. Priority restoration areas (which could reduce the 5% cap)
      A. Areas where plug and abandon activities will eliminate disturbance
      B. Areas where old reclamation has not produced suitable habitat
   v. Areas of invasive species
   vi. Other assurances in place (CCAA, easements, habitat, contracts, etc.)

4. Determination of existing and allowable suitable habitat disturbance: Acres of disturbance within suitable habitat divided by the total suitable habitat within the DDCT area times 100 equals the percent of disturbed suitable habitat within the DDCT area. Subtracting the percentage of existing disturbed suitable habitat from 5% equals new allowable suitable habitat disturbance until plant regeneration or reclamation reduces acres of disturbed habitat within the DDCT area.

Permitting: The complete analysis package developed by consultation and review outlined herein will be forwarded to the appropriate permitting agency. WGFD recommendations will be included, as will other recommendations from project proponents and other appropriate agencies. Project proponent shall have access to all information used in developing recommendations. Where possible and when requested by the project proponent, state agencies shall provide the project proponent with development alternatives other than those contained in the project proposal.

Exempt Activities: A list of exempt ("de minimus") activities, including standard uses of the landscape is available in Attachment C.

GENERAL STIPULATIONS

These stipulations are designed to maintain existing suitable sage-grouse habitat by permitting development activities in core areas in a way that will not cause declines in sage-grouse populations. General stipulations are recommended to apply to all activities in core areas, with the exception of exempt ("de minimus") actions defined herein (Attachment C) or specifically identified activities. The specific industry stipulations are considered in addition to the general stipulations.

1. **Surface Disturbance:** Surface disturbance will be limited to 5% of suitable sage-grouse habitat per an average of 640 acres. The DDCT process will be used to determine the

level of disturbance. Distribution of disturbance may be considered and approved on a case-by-case basis. Unsuitable habitat should be identified in a seasonal and landscape context, on a case-by-case basis, outside the 0.6 mile buffer around leks. This will incentivize proponents to locate projects in unsuitable habitat to avoid creating additional disturbance acres. Acres of development in unsuitable habitat are not considered disturbance acres. The primary focus should be on protection of suitable habitats and protecting from habitat fragmentation. See Appendix 1 for a description of suitable, unsuitable habitat and disturbance.

2. **Surface Occupancy:** Within 0.6 miles of the perimeter of occupied sage-grouse leks there will be no surface occupancy (NSO). NSO, as used in these recommendations, means no surface facilities including roads shall be placed within the NSO area. Other activities may be authorized with the application of appropriate seasonal stipulations, provided the resources protected by the NSO are not adversely affected. For example, underground utilities may be permissible if installation is completed outside applicable seasonal stipulation periods and significant resource damage does not occur. Similarly, geophysical exploration may be permissible in accordance with seasonal stipulations.

3. **Seasonal Use:** Activity (production and maintenance activity exempted) will be allowed from July 1 to March 14 outside of the 0.6 mile perimeter of a lek in core areas where breeding, nesting and early brood-rearing habitat is present. In areas used solely as winter concentration areas, exploration and development activity will be allowed March 14 to December 1. Activities in unsuitable habitat may also be approved year-round (including March 15 to June 30) on a case-by-case basis (except in specific areas where credible data shows calendar deviation). Activities may be allowed during seasonal closure periods as determined on a case-by-case basis. While the bulk of winter habitat necessary to support core sage-grouse populations likely occurs inside Core Population Areas, seasonal stipulations (December 1 to March 14) should be considered in locations outside Core Population Areas where they have been identified as winter concentration areas necessary for supporting biologically significant numbers of sage-grouse nesting in Core Population Areas. All efforts should be made to minimize disturbance to mature sagebrush cover in identified winter concentration areas.

4. **Transportation:** Locate main roads used to transport production and/or waste products > 1 .9 miles from the perimeter of occupied sage-grouse leks. Locate other roads used to provide facility site access and maintenance > 0.6 miles from the perimeter of occupied sage-grouse leks. Construct roads to minimum design standards needed for production activities.

5. **Overhead Lines:** Bury lines when possible, if not; locate overhead lines at least 0.6 miles from the perimeter of occupied sage-grouse leks. New lines should be raptor proofed if not buried.

6. **Noise:** New noise levels, at the perimeter of a lek, should not exceed 10 dBA above ambient noise (existing activity included) from 6:00 p.m. to 8:00 a.m. during the initiation of breeding (March 1 – May 15). Ambient noise levels should be determined by measurements taken at the perimeter of a lek at sunrise.

7. **Vegetation Removal:** Vegetation removal should be limited to the minimum disturbance required by the project. All topsoil stripping and vegetation removal in suitable habitat

will occur between July 1 and March 14 in areas that are within 4 miles of an occupied lek. Initial disturbance in unsuitable habitat between March 15 and June30 may be approved on a case-by-case basis.

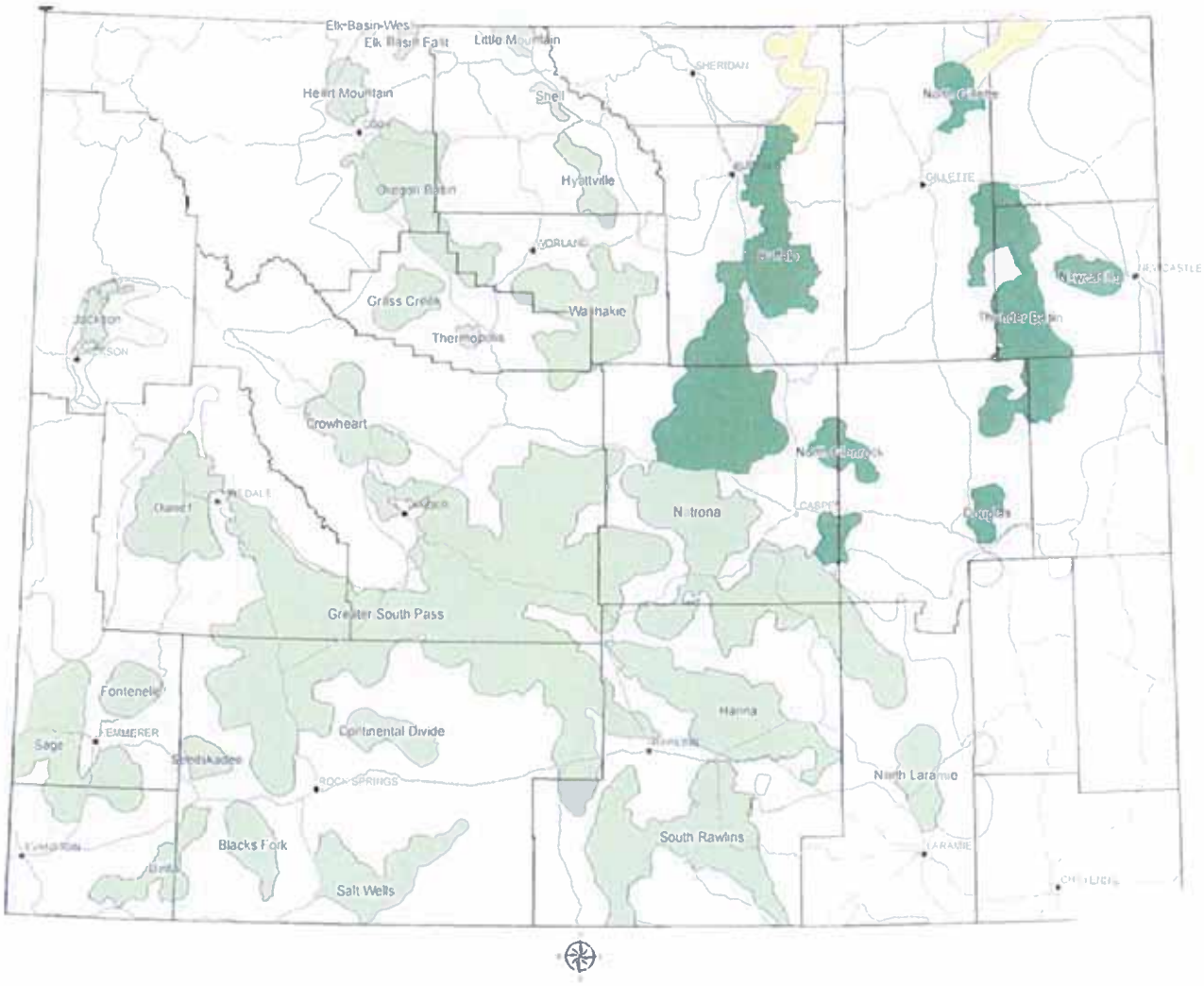
8. **Sagebrush Treatment:** Sagebrush eradication is considered disturbance and will contribute to the 5% disturbance factor. Northeast Wyoming, as depicted in Figure 1, is of particular concern because sagebrush habitats rarely exceed 15% canopy cover and large acreages have already been converted from sagebrush to grassland or cropland. Absent some demonstration that the proposed treatment will not reduce canopy cover to less than 15% within the treated area, habitat treatments in northeast Wyoming (Figure 1) should not be conducted. In stands with less than 15% cover, treatment should be designed to maintain or improve sagebrush habitat. Sagebrush treatments that maintain sagebrush canopy cover at or above 15% total canopy cover within the treated acres will not be considered disturbance. Treatments that reduce sagebrush canopy cover below 15% will be allowed, excluding northeast Wyoming (Figure 1), if all such treated areas make up less than 20% of the suitable sagebrush habitat within the DDCT, and any point within the treated area is within 60 meters of sagebrush habitat with 10% or greater canopy cover. Treatments to enhance sagebrush/grassland will be evaluated based upon the existing habitat quality and the functional level post-treatment.

9. **Monitoring/adaptive response:** Proponents of new projects are expected to coordinate with the permitting agency and local WGFD biologist to determine which leks need to be monitored and what data should be reported by the proponent. Certain permits may be exempted from monitoring activities pending permitting agency coordination. If declines in affected leks (using a three-year running average during any five year period relative to trends on reference leks) are determined to be caused by the project, the operator will propose adaptive management responses to increase the number of birds. If the operator cannot demonstrate a restoration of bird numbers to baseline levels (established by pre-disturbance surveys, reference surveys and taking into account regional and statewide trends) within three years, operations will cease until such numbers are achieved.

10. **Reclamation:** Reclamation should re-establish native grasses, forbs and shrubs during interim and final reclamation to achieve cover, species composition, and life form diversity commensurate with the surrounding plant community or desired ecological condition to benefit sage-grouse and replace or enhance sage-grouse habitat to the degree that environmental conditions allow. Seed mixes should include two native forbs and two native grasses with at least one bunchgrass species. Where sagebrush establishment is prescribed, establishment is defined as meeting the standard prescribed in the individual reclamation plan. Landowners should be consulted on desired plant mix on private lands. The operator is required to control noxious and invasive weed species, including cheatgrass. Rollover credit, if needed, will be outlined in the individual project reclamation plan.

    Credit may be given for completion of habitat enhancements on bond released or other minimally functional habitat when detailed in a plan. These habitat enhancements may be used as credit for reclamation that is slow to establish in order to maintain the disturbance cap or to improve nearby sage-grouse habitat.

Figure 1. Wyoming Core Area with northeast Wyoming core (dark green) and connectivity areas (yellow).



11. **Existing Activities:** Areas already disturbed or approved for development within Core Areas prior to August 1, 2008 are not subject to new sage-grouse stipulations with the exception existing operations may not initiate activities resulting in new surface occupancy within 0.6 mile of the perimeter of a sage-grouse lek. Any existing disturbance will be counted toward the calculated disturbance cap for a new proposed activity. The level of disturbance for existing activity and rollover credit may exceed 5%.

12. **Exceptions:** Any exceptions to these general or specific stipulations will be considered on a case by case basis and must show that the exception will not cause declines in sage-grouse populations.

SPECIFIC STIPULATIONS (To be applied in addition to general stipulations)

1. Oil and Gas: Well pad densities not to exceed an average of one pad per square mile (640 acres) and suitable habitat disturbed not to exceed 5% of suitable habitat within the DDCT. As an example, the number of well pads within a two mile radius of the perimeter of an occupied sage-grouse lek should not exceed 11, distributed preferably in a clumped pattern in one general direction from the lek.

2. Mining

   a. For development drilling or ore body delineation drilled on tight centers, (approximately 100'X100') the disturbance area will be delineated by the external limits of the development area. Assuming a widely-spaced disturbance pattern, the actual footprint will be considered the disturbance area.
   b. Monitoring results will be reported annually in the mine permit annual report and to WGFD. Pre-disturbance surveys will be conducted as required by the appropriate regulatory agency.
   c. The number of active mining development areas (e.g., operating equipment and significant human activity) are not to exceed an average of one site per square mile (640 acres) within the DDCT.
   d. Surface disturbance and surface occupancy stipulations will be waived within the Core Area when implementing underground mining practices that are necessary to protect the health, welfare, and safety of miners, mine employees, contractors and the general public. The mining practices include but are not limited to bore holes or shafts necessary to: 1) provide adequate oxygen to an underground mine; 2) supply inert gases or other substances to prevent, treat, or suppress combustion or mine fires; 3) inject mine roof stabilizing substances; and 4) remove methane from mining areas. Any surface disturbance or surface occupancy necessary to access the sites to implement these mining practices will also be exempt from any stipulation.
   e. Coal mining operations will be allowed to continue under the regulatory and permit-specific terms and conditions authorized under the federal Surface Mining Control and Reclamation Act.

3. Connectivity:

   a. The suspension of federal and state leases in connectivity corridors (Figure 1) is encouraged where there is mutual agreement by the leasing agency and the operator. These suspensions should be allowed until additional information

clarifies their need. Where suspensions cannot be accommodated, disturbance should be limited to no more than 5% (up to 32 acres) per 640 acres of suitable sage-grouse habitat within connectivity corridors.

b. For protection of connectivity corridors (Figure 1), a controlled surface use (CSU) buffer of 0.6 miles around leks or their documented perimeters is required. In addition, a March 15 to June 30 timing limitation stipulation is required within nesting habitat within 4 miles of leks.

4. Process Deviation or Undefined Activities: Development proposals incorporating less restrictive stipulations or development that is not covered by these stipulations may be considered depending on site-specific circumstances and the proponent must have data demonstrating that the alternative development proposal will not cause declines in sage-grouse populations in the core area. Proposals to deviate from standard stipulations will be considered by a team including WGFD and the appropriate land management and permitting agencies, with input from the U.S. Fish and Wildlife Service. Project proponents need to demonstrate that the project development would meet at least one of the following conditions:

a. No suitable habitat is present in one contiguous block of land that includes at least a 0.6 mile buffer between the project area and suitable habitat;

b. No sage-grouse use occurs in one contiguous block of land that includes at least a 0.6 mile buffer between the project area and adjacent occupied habitat, as documented by total absence of sage-grouse droppings and an absence of sage-grouse activity for the previous ten years;

c. Provision of a development/mitigation plan that has been implemented and demonstrated by previous research not to cause declines in sage-grouse populations. The demonstration must be based on monitoring data collected and analyzed with accepted scientific based techniques.

5. Wind Energy Development: Wind development is not recommended in sage-grouse core areas, but will be reevaluated on a continuous basis as new science, information and data emerges.

Appendix I
Suitable Sage-Grouse Habitat Definition

Sage-grouse require somewhat different seasonal habitats distributed over large areas to complete their life cycle. All of these habitats consist of, are associated with, or are immediately adjacent to, sagebrush. If sage-grouse seasonal habitat use maps do not exist for the project site the following description of suitable habitat should be used to determine areas of unsuitable sage-grouse habitat for development siting purposes. An abbreviated description of a complex system cannot incorporate all aspects of, or exceptions to, what habitats a local sage-grouse population may or may not utilize.

Suitable sage-grouse habitat (nesting, breeding, brood-rearing, or winter) is within the mapped occupied range of sage-grouse, and:

1) has 5% or greater sagebrush canopy cover as measured by the technique developed by interagency efforts. "Sagebrush" includes all species and sub-species of the genus Artemisia except the mat-forming sub-shrub species: frigida (fringed) and pedatifida (birdfoot); or
2) is riparian, wet meadow (native or introduced) or areas of alfalfa or other suitable forbs (brood rearing habitat) within 60 meters of sagebrush habitat with 10% or greater canopy cover and the early brood rearing habitat does not exceed 20% of the suitable sagebrush habitat present within the DDCT, Larger riparian/wet meadow, and grass/forb producing areas may be considered suitable habitat as determined on a case by case basis.

Transitional sage-grouse habitat is land that has been treated or burned prior to 2011 resulting in <5% sagebrush cover but is actively managed to meet a minimum of 5% sagebrush canopy cover with associated grasses and forbs by 2021 (by analysis of local condition and trend) and may or may not be considered disturbed. Land that does not meet the above vegetation criteria by 2021 should be considered disturbed.

Land treatments post 2010 must meet sagebrush vegetation treatment guidelines or the treatment will be considered disturbed. Following wildfire, lands shall be treated as disturbed pending an implementation management plan with trend data showing the area returning to functional sage-grouse habitat.

To evaluate the 5% disturbance cap per average 640 acres using the DDCT, suitable habitat is considered disturbed when it is removed and unavailable for immediate sage-grouse use.

The following items are guidelines for determining suitable habitat:

a. Long-term removal occurs when habitat is physically removed through activities that replace suitable habitat with long term occupancy of unsuitable habitat such as a road, well pad or active mine.
b. Short—term removal occurs when vegetation is removed in small areas, but restored to suitable habitat within a few years of disturbance, such as a successfully reclaimed pipeline, or successfully reclaimed drill hole or pit.
c. There may be additional suitable habitat considered disturbed between two or more long term (greater than 1 year) anthropogenic disturbance activities with a footprint greater than 10 acres each if the activities are located such that sage-grouse use of the suitable habitat between these activities is significantly reduced due to the close proximity (less than 1.2 miles apart, 0.6 miles from each activity) and resulting in cumulative effects of these large scale activities. Exemptions may be provided.

d. Land in northeast Wyoming (Figure 1 of Attachment B) that has had sagebrush removed post-1994 (based on Orthophoto interpretation) and not recovered to suitable habitat will be considered disturbed when using the DDCT.

ATTACHMENT C
Exempt ("de minimus") Activities

Existing Land Uses and Landowner Activities in Greater Sage-Grouse Core Population Areas That Do Not Require State Agency Review for Consistency With Executive Order No. 2011-05

1. Existing animal husbandry practices (including branding, docking, herding, trailing, etc).

2. Existing farming practices (excluding conversion of sagebrush/grassland to agricultural lands).

3. Existing grazing operations that utilize recognized rangeland management practices (allotment management plans, NRCS grazing plans, prescribed grazing plans, etc).

4. Construction of agricultural reservoirs and habitat improvements less than 10 surface acres and drilling of agriculture and residential water wells (including installation of tanks, water windmills and solar water pumps) more than 0.6 miles from the perimeter of the lek. Within 0.6 miles from leks no review is required if construction does not occur March 15 to June 30 and construction does not occur on the lek. All water tanks shall have escape ramps.

5. Agricultural and residential electrical distribution lines more than 0.6 miles from leks. Within 0.6 miles from leks no review is required if construction does not occur March 1 5 to June 30 and construction does not occur on the lek. Raptor perching deterrents shall be installed on all poles within 0.6 miles from leks.

6. Agricultural water pipelines if construction activities are more than 0.6 miles from leks. Within 0.6 miles from leks no review is required if construction does not occur March 15 to June 30 and construction is reclaimed.

7. New fencing more than 0.6 miles from leks and maintenance on existing fence. For new fencing within 0.6 miles of leks, fences with documented high potential for strikes should be marked.

8. Irrigation (excluding the conversion of sagebrush/grassland to new irrigated lands).

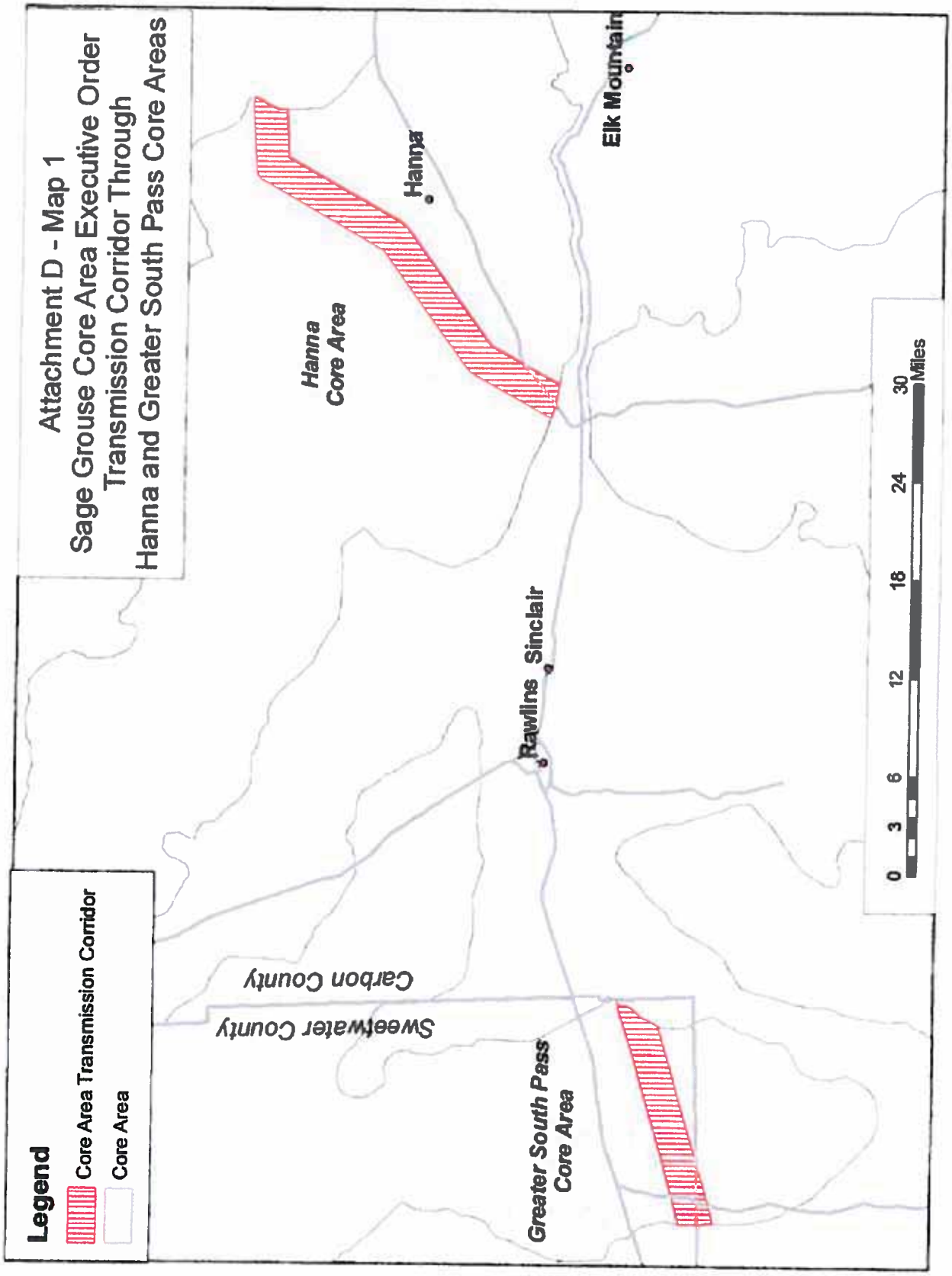
9. Spring development if the spring is protected with fencing and enough water remains at the site to provide mesic (wet) vegetation.

10. Herbicide use within existing road, pipeline and power line rights-of-way. Herbicides application using spot treatment. Grasshopper/Mormon cricket control following Reduced Agent-Area Treatments (RAATS) protocol.

11. Existing county road maintenance.

12. Cultural resource pedestrian surveys.

13. Emergency response.


Attachment D - Map 1
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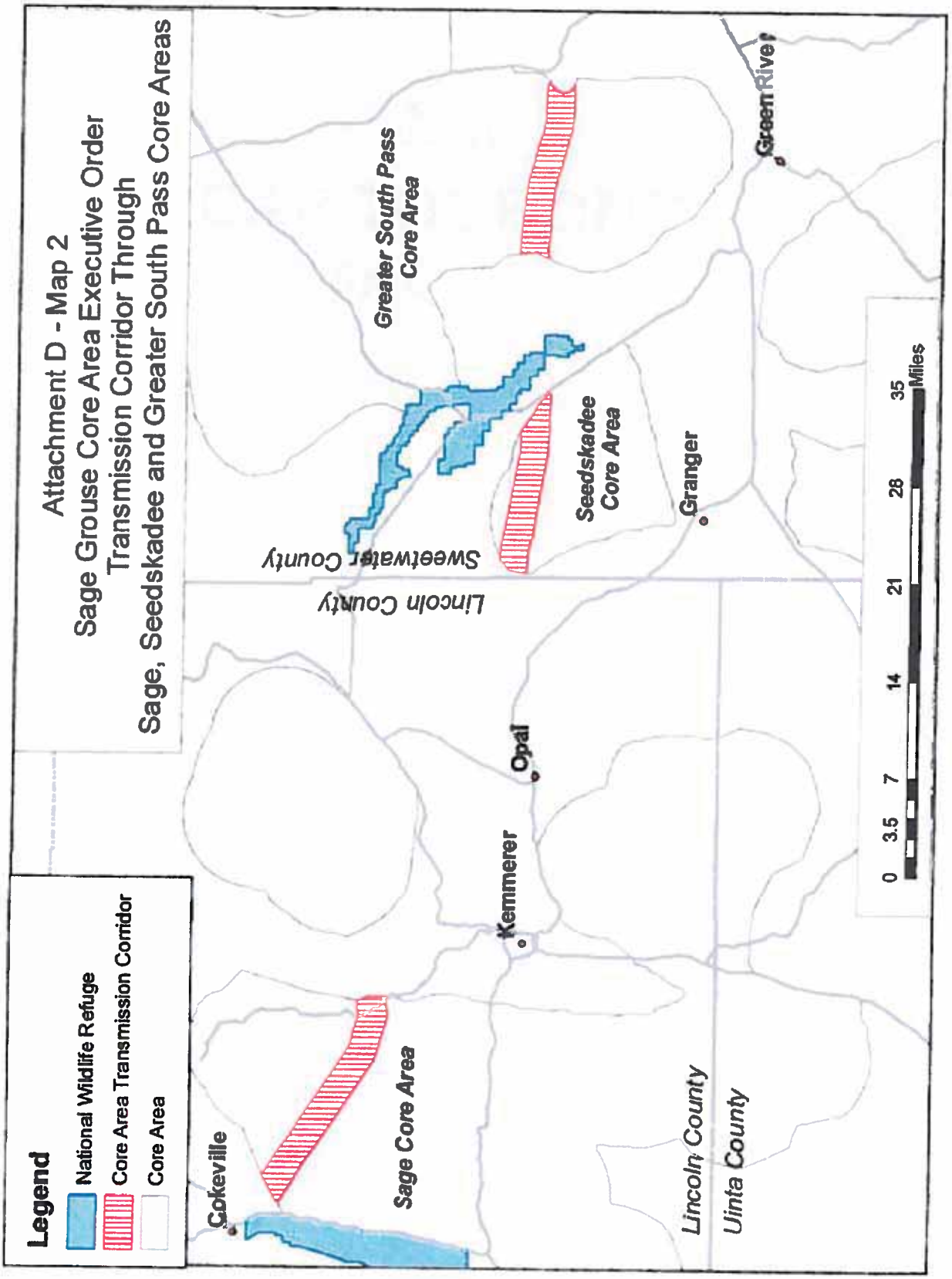
Transmission Corridor Through
Hanna and Greater South Pass Core Areas
Legend
Core Area Transmission Corridor
Core Area
Hanna Core Area
Hanna
Elk Mountain
Rawlins
Sinclair
Greater South Pass Core Area
Sweetwater County
Carbon County
0
3
6
12
18
24
30
Miles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Transmission Corridor Through
Sage, Seedskadee and Greater South Pass Core Areas
Legend
National Wildlife Refuge
Core Area Transmission Corridor
Core Area
Cokeville
Sage Core Area
Kemmerer
Opal
Lincoln County
Sweetwater County
Lincoln County
Uinta County
Seedskadee Core Area
Granger
Greater South Pass Core Area
Green River
0
3.5
7
14
21
28
35
Miles

Conservation Plan for the Greater Sage-grouse in Idaho

July 2006

Conservation Plan for the Greater Sage-grouse in Idaho

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Executive Summary

Overview

The greater sage-grouse has historically been, and continues to be, an important species across the western rangelands. Centuries before European settlement of western North America, this bird was of ceremonial and subsistence significance to native peoples in the region. Sage-grouse are an important part of the sagebrush community and are also sometimes used as a measure of sagebrush ecosystem health.

Historical populations of sage-grouse in Idaho are not well documented. Prior to 1900 sage-grouse were not protected in Idaho. The first Idaho sage-grouse hunting season was established in 1900. As early as the 1920s, wildlife managers voiced concern about the future of Idaho's sage-grouse populations. In a trend mirroring that seen in other western states, Idaho has experienced substantial alteration and losses of sagebrush steppe habitat since European settlement.

The state of Idaho continues play a leadership role in sage-grouse conservation planning, monitoring and evaluation, and research activities. In 1997, the Idaho Sage-grouse Task Force, under direction of the Idaho Fish and Game Commission, completed the Idaho Sage-grouse Management Plan (IDFG 1997). The 1997 Plan divided Idaho into sage-grouse management areas and called for the creation of Local Working Groups (LWG) that would develop sage-grouse management plans for each of Idaho's sage-grouse planning areas. Since 1997 Local Working Group plans have been completed or drafted in 5 Sage-grouse Planning Areas (SGPA).

Between May 1999 and December 2003, the U.S. Fish and Wildlife Service (USFWS) received eight petitions to list as endangered or threatened, various populations of sage-grouse. In April 2004, USFWS determined that three of the petitions to list the greater sage-grouse as threatened provided substantial information that listing might be warranted, thus initiating a comprehensive range-wide status review. On January 7, 2005, a finding of Not Warranted was published in the Federal Register.

This 2006 Conservation Plan for the Greater Sage-grouse in Idaho (Plan) replaces the 1997 Idaho Sage-grouse Management Plan. This Plan incorporates significant new information and data and provides the overarching scientific and management framework within which the completed LWGs Plans will function.

This Plan includes:

- Background information and resources regarding sage-grouse and sagebrush ecology;
- A summary of the status of sage-grouse populations and habitat in Idaho;
- Identification and discussion of 19 threats to sage-grouse and their habitats;
- A toolbox of conservation measures to address each of those threats;
- Research, monitoring and evaluation guidelines and recommendations; and
- A number of appendices that provide additional information.

Management framework

The Sage-grouse Local Working Groups (LWGs) are the heart of Idaho's sage-grouse conservation strategy. The collaborative development and implementation of LWG plans is vital to successful conservation of sage-grouse in Idaho. This Plan is designed to provide guidance, tools, and resources to LWGs to facilitate development of their plans, while also encouraging a level of statewide consistency among the LWG plans. Establishment of LWGs in Sage-grouse Planning Areas (SGPAs) that currently lack them, and completion of LWG plans in all of Idaho's SGPAs, are significant priorities in Idaho.

Under the framework outlined in this Plan, the LWG plans will identify and prioritize local threats, and identify appropriate conservation measures at the mid- and fine-scale, while this state Plan identifies and prioritizes threats at the broad-scale. This Plan also provides a toolbox of fine-scale conservation measures for use and/or adaptation by LWGs (as appropriate to local population and habitat conditions), and for use in cases where a LWG plan has not been completed, or where no LWG currently exists.

Long-term monitoring of sage-grouse populations and habitats is crucial. This Plan outlines ways to accomplish this efficiently and effectively. Local working groups and others can then use these data to make good management decisions to conserve Idaho sage-grouse.

Goals

The primary goal of this Plan is to:

Maintain, improve, and where possible, increase sage-grouse populations and habitats in Idaho, while considering the predictability and long-term sustainability of a variety of other land uses.

Secondary goals of this Plan include:

1) Establishing broadly representative Local Working Groups in all SGPAs that currently lack them;

2) Fostering and supporting effective LWGs and their activities, throughout the range of sage-grouse in Idaho;

3) Fostering and supporting completion of LWG plans for all of Idaho's SGPAs and;

4) Fostering and supporting effective coordination among state and federal agencies, Tribes, and non-governmental cooperators to achieve the primary goal of this Plan.

Population and habitat objectives

The population objectives identified in this Plan are:

1) Maintain, and increase where possible, the present distribution and abundance of sage-grouse in Idaho; and

2) Reduce, eliminate, or mitigate the adverse impacts of human-related or unnatural disturbance to sage-grouse within or near breeding and winter habitat throughout Idaho.

The habitat objectives identified in this Plan are:

1) Maintain, enhance or restore sage-grouse habitat, and continuity of habitats, at multiple spatial scales; and

2) Manage Idaho's landscape to foster a dynamic sagebrush ecosystem that includes a diverse species composition of sagebrush, grasses, and forbs; and incorporates structural characteristics that promote rangeland health in general, and sage-grouse habitat requirements in particular.

Specific numeric population and habitat objectives will be refined and developed through the LWG planning processes, consistent with data developed through broad- mid- and fine-scale monitoring and evaluation activities, and then incorporated into future revisions of this Plan.

Threats and conservation measures

This Plan presents a discussion of 19 threats to sage-grouse and their habitats, together with a toolbox of conservation measures designed to address each individual threat. Priorities will differ by SGPA depending on local conditions. LWGs are expected to develop a list of local threats specific to their area. The recommended conservation measures associated with each threat are designed to eliminate, reduce, or mitigate threats to sage-grouse or to ensure the long-term sustainability of sage-grouse habitat in Idaho. Local Working Groups are encouraged to adopt these conservation measures or others that are more locally appropriate. The conservation measures identified in this Plan should be implemented where feasible unless documented to be inappropriate at the site or project scale. Examples of such documentation could include: description of alternative conservation measures arising from site-specific analysis, monitoring, research, or adaptive management.

Research, monitoring and evaluation

This Plan includes discussion of research, monitoring and evaluation needs, guidelines and protocols for sage-grouse population monitoring, guidelines and protocols for sage-grouse habitat evaluation and monitoring, and related adaptive management recommendations.

Although a great deal is known about sage-grouse ecology and habitat, additional research is needed in order to better understand the range of factors that affect sage-grouse populations, sage-grouse habitat, and the relationship between them. Research is also needed to identify better ways of addressing both population and habitat needs.

The evaluation and monitoring of sage-grouse habitats and selected threats are crucial components in the implementation of this Plan. Standardized approaches for the collection and aggregation of spatial and tabular data across multiple scales are

presented along with specific tasks, timelines, and responsible parties. In some cases processes or protocols still need to be developed; in these cases suggested tasks and timelines are identified in the Plan to facilitate further action.

Implementation

In implementing this Plan and the LWG plans, a variety of multi-disciplinary expertise will be required. The commitment of landowners, resource users, and agency personnel to implementing the conservation measures, and monitoring and evaluation actions identified in this Plan, and in the LWG plans, is essential to successful conservation of sage-grouse and their habitat in Idaho.

When sage-grouse concerns arise at the local level, LWGs, agency representatives, landowners, and others will look first to the appropriate LWG plan for specific guidance. If a LWG plan is silent on the issue of concern, parties would look next to the state Plan for guidance. The LWGs are expected to work with, and through, the appropriate federal and state agencies, landowners, and regulatory processes to implement the conservation measures/actions identified in their LWG plans to reduce, eliminate, or mitigate identified threats to sage-grouse and sage-grouse habitat.

This Plan is intended to be a "living document" that will be periodically updated and/or amended as appropriate.

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iv Acknowledgements

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Bruce Ackerman, Biometrician, Idaho Department of Fish and Game, Wildlife Bureau; **Dr. Robert Anson**, Department of Networking, Operations and Information Systems, Boise State University; **K Lynn Bennett**, State Director, Idaho Bureau of Land Management State Office; **Bart Butterfield**, GIS Manager, Idaho Department of Fish and Game; **Christa Braun**, Cartographic Technician, Idaho Bureau of Land Management State Office; **Jim Caswell**, Administrator, Governor's Office of Species Conservation; **Mark Collinge**, Idaho State Director, US Department of Agriculture Aphis-Wildlife Services; **Jeff Cook**, Outdoor Recreation Analyst, Idaho Department of Recreation**; John Courtright**, Information Technology Specialist, Idaho Bureau of Land Management State Office; **Kevin Church**, Program Coordinator, Idaho Department of Fish and Game, Conservation Data Center; **Crystal Christensen**, Office Specialist, Idaho Department of Fish and Game; **Brett Dumas**, Terrestrial Ecologist, Idaho Power Company; **Tim Dykstra**, Director Fish, Wildlife and Parks, Shoshone-Paiute Tribes; **Sean Finn**, GIS Specialist, US Geological Survey Snake River Field Station; **Jonathon Foster**, Resources and Science Branch Chief, Idaho Bureau of Land Management State Office; **Nicholas Hardy**, GIS Technician, Idaho Bureau of Land Management State Office; **Chuck Harris**, Nongame Wildlife Manager, Idaho Department of Fish and Game; **Susan Giannettino**, Deputy State Director, Resources, Idaho Bureau of Land Management State Office; **Terry Heslin**, Outdoor Recreation Planner, Idaho Bureau of Land Management State Office; **Rich Howard**, U.S. Fish and Wildlife Service, Retired; **Steven Huffaker**, Director, Idaho Department of Fish and Game; **Wendy Lowe**, Facilitator, Upper Snake, Challis, and Curlew Local Working Groups; **Rance Marquez**, Fire Use Specialist, Burley Field Office, Bureau of Land Management; **Diane McConnaughey**, GIS Specialist, Idaho Bureau of Land Management State Office; **Cindy Lou McDonald**, Geographic Sciences Specialist, Idaho Bureau of Land Management State Office; **Rich McDowell**, Cartographic Technician, Idaho Bureau of Land Management State

Office; **Tom Miles**, Rangeland Management Specialist, Idaho Bureau of Land Management State Office; **Dave Musil**, Senior Wildlife Research Biologist, Idaho Department of Fish and Game; **Andy Payne**, Field Office Manager, Shoshone Field Office, Bureau of Land Management; **Mike Pellant**, Great Basin Restoration Initiative Coordinator, Nevada Bureau of Land Management State Office; **Michele Porter**, GIS Specialist, Idaho Bureau of Land Management State Office; **Barry Rose**, Supervisory Public Affairs Specialist, Idaho Bureau of Land Management State Office; **Roger Rosentreter**, Botanist, Idaho BLM State Office; **Alan Sands**, Sage-grouse Habitat Restoration Coordinator, The Nature Conservancy; **Signe Sather-Blair**, Wildlife Biologist, Idaho Bureau of Land Management State Office; **Elena Shaw**, Resource Coordinator, Twin Falls District, Bureau of Land Management; **David Smith**, Office Specialist, Idaho Department of Fish and Game; **Nicole Ulacky**, GIS Technician, Idaho Bureau of Land Management State Office; and, **Krista Gollnick-Waid**, Fire-Use Specialist, Idaho Bureau of Land Management State Office.

Members of the Idaho Sage-grouse Advisory Committee provided important and essential guidance and review in the development of this plan.

Idaho Sage-grouse Advisory Committee Members:

John Augsburger, Bureau of Land Management; **Tracy Behrens**, Idaho Department of Lands; **Donna Bennett**, Owyhee Local Working Group; **Russ Boyer**, Curlew Local Working Group; **LaVelle Braun**, West Central Local Working Group; **Ted Chu**, Idaho Conservation League; **Ken Crane**, Idaho Department of Agriculture; **Dr. Stephen Goddard**, Idaho Birdhunters, Ada County Fish and Game League, Idaho Wildlife Federation; **Jim Hagenbarth**, Upper Snake Local Working Group; **Robbert Mickelsen**, US Forest Service; **Dr. William Platts**; **Peggy Redick**, Challis Local Working Group (Interim); **Mike Remming**, Jarbidge LWG; **Rob Rogerson**, Shoshone Local Working Group; **John Romero**, Idaho Cattle Association; and, **Dan Gossett**, Shoshone-Paiute Tribes.

Idaho Sage-grouse Advisory Committee Technical Advisors:

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The following experts participated in an "Expert Science Review Panel" discussion to identify and prioritize statewide threats to sage-grouse and regional extirpation risks. The results of this science panel have been invaluable in the drafting of this plan. Moreover, a number of these individuals provided additional input and expertise that was vital to the development of this plan:

Idaho Sage-grouse Science Panel Members:

Dr. Stephen Bunting, Professor, Department of Rangeland Ecology and Management, University of Idaho; **Dr. Jack Connelly**, Principal Wildlife Research Biologist, IDFG; **Dr. Steve Knick**, Research Ecologist, U.S. Geological Survey; **Dr. Karen Launchbaugh**, Department Head, Rangeland Ecology and Management, University of Idaho; **Dr. Kerry Reese**, Department Head, Fisheries and Wildlife Resources, University of Idaho, and; **Dr. J. Michael Scott**, Leader, Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho.

Finally, members of the Subcommittee wish to extend their appreciation to the many individuals who provided thoughtful and insightful reviews of the evolving drafts of this document.

v Acronyms

APHIS	Animal and Plant Health Inspection Service
ATV	All Terrain Vehicle.
BAER	Burned Area Emergency Rehabilitation
BIA	Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
CREP	Conservation Reserve Enhancement Program
CSP	Conservation Security Program
DOD	Department of Defense
DOE	Department of Energy
EQIP	Environmental Quality Incentive Program
ERUs	Ecosystem Reporting Units
ESA	Endangered Species Act
ESR	Emergency Stabilization and Rehabilitation
FMP	Fire Management Plan
FMU	Fire Management Unit
GBRI	Great Basin Restoration Initiative
GIS	Geographic Information System
ICBEMP	Interior Columbia Basin Ecosystem Management Project
IDFG	Idaho Department of Fish and Game
IDL	Idaho Department of Lands
IDPR	Idaho Department of Parks and Recreation
IDWR	Idaho Department of Water Resources
INL	Idaho National Laboratory
IRMP	Integrated Resources Management Plan
ISDA	Idaho State Department of Agriculture
LWG	Local Working Group
MOU	Memorandum of Understanding
NEPA	National Environmental Policy Act
NF	National Forest
NFOP	Normal Fire Operations Plan
NGOs	Non-Governmental Organizations
NMFS	National Marine Fisheries Service
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
OHV	Off-highway Vehicle
OSC	Office of Species Conservation
PECE	Policy for Evaluation of Conservation Efforts (USFWS)

PFC	Proper Functioning Condition
PPQ	Plant Protection and Quarantine (USDA APHIS)
RFD	Rural Fire Department
SAC	Idaho statewide Sage-grouse Advisory Committee
SAC TAT	Sage-grouse Advisory Committee Technical Assistance Team
SGHPM	Sage-grouse Habitat Planning Map
SGPA	Sage-grouse Planning Area
USDA	U.S. Department of Agriculture
USDI	U.S. Department of Interior
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
UV	Ultraviolet
WAFWA	Western Association of Fish and Wildlife Agencies
WHIP	Wildlife Habitat Incentives Program (NRCS)
Wildlife Services	USDA-APHIS-Wildlife Services
WNV	West Nile Virus

vi Endorsements of Conservation Plan for the Greater Sage-grouse in Idaho

This Conservation Plan for Sage-grouse in Idaho (Plan) summarizes the status of sage-grouse habitats and populations in Idaho, identifies statewide threats, and is intended to facilitate the implementation of conservation measures by state and federal agencies, Tribes, and willing non-governmental cooperators; and to complement and enhance the efforts of Local Working Groups. This Plan is the product of a collaborative effort that included state and federal resource agencies, Tribes, and non-governmental cooperators. Consultation and coordination with the Tribes will also occur through appropriate federal agency protocols.

This Plan will be implemented through the collaborative efforts of state and federal agencies, Tribes, Local Working Groups, and other willing non-governmental cooperators.

The following Sage-grouse Advisory Committee signature page and Memorandum of Understanding are intended to signal the commitment of various entities to collaboratively implement this Plan, while also acknowledging the different authorities, missions, and interests of the various parties to this Plan.

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Idaho Sage-grouse Advisory Committee Signature Page

Recognizing that this signature page has no legal authority to bind any individual, agency, or non-governmental organization to any specific action, the following members of the Idaho Sage-grouse Advisory Committee (SAC) agree, in their capacity as members of the SAC, to their endorsement of this Conservation Plan for Sage-grouse in Idaho (Plan); and agree to work collaboratively through the Idaho Local Working Groups, and other appropriate mechanisms, to support the intent and actions identified in this Plan.

This signature page applies only to the state Plan and does not imply individual endorsement of the LWG plans attached in Appendix J.

John Augsburger Bureau of Land Management	Date
Tracy Behrens Idaho Department of Lands	Date
Donna Bennett Chair, Owyhee Local Working Group	Date
Russ Boyer Member, Curlew Local Working Group	Date
Gene Gray Member, West Central Local Working Group	Date
Ted Chu Idaho Conservation League	Date
Ken Crane Bureau of Land Management	Date

Dr. Stephen Goddard Idaho Birdhunters, Ada County Fish and Game League, Idaho Wildlife Federation	Date
Dan Gossett Sage-grouse Project Coordinator, Shoshone-Paiute Tribes	Date
Jim Hagenbarth Member, Upper Snake Local Working Group	Date
Robbert Mickelsen U.S. Forest Service	Date
Dr. William Platts Citizen Participant	Date
Peggy Redick Member, Challis Local Working Group	Date
Mike Remming Member, Jarbidge Local Working Group	Date
Rob Rogerson Member, Shoshone Local Working Group	Date
John Romero Idaho Cattle Association	Date

Memorandum of Understanding

BETWEEN THE STATE OF IDAHO
BY AND THROUGH THE
DEPARTMENT OF AGRICULTURE,
DEPARTMENT OF FISH AND GAME,
DEPARTMENT OF LANDS,
OFFICE OF SPECIES CONSERVATION

AND

UNITED STATES DEPARTMENT OF INTERIOR
BUREAU OF LAND MANAGEMENT,
UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE-INTERMOUNTAIN REGION,
ANIMAL AND PLANT HEALTH INSPECTION SERVICE-WILDLIFE SERVICES,
NATURAL RESOURCES CONSERVATION SERVICE

This Memorandum of Understanding (MOU) is entered into by the STATE OF IDAHO, IDAHO DEPARTMENT OF AGRICULTURE (ISDA), IDAHO DEPARTMENT OF FISH AND GAME (IDFG), IDAHO DEPARTMENT OF LANDS (IDL), OFFICE OF THE GOVERNOR, OFFICE OF SPECIES CONSERVATION (OSC) AND the USDI BUREAU OF LAND MANAGEMENT (BLM), USDA FOREST SERVICE (FS), USDA APHIS-WILDLIFE SERVICES and USDA NATURAL RESOURCES CONSERVATION SERVICE (NRCS) (collectively referred to as the Parties).

INTRODUCTION

WHEREAS, the parties agree that sage-grouse are an important natural component of the sagebrush ecosystem. To this end, the parties hereby enter into this MOU for the purpose of supporting and implementing, to the extent practicable and where appropriate, the intent and actions contained in the **2006 Conservation Plan for the Greater Sage-grouse in Idaho**.

WHEREAS, the parties herein agree that increased cooperative efforts, consistent with applicable statutory requirements, Local Working Groups (LWGs) and their respective Plans, and the State-wide Plan, are necessary to conserve sagebrush ecosystems for the benefit of sage-grouse, other sagebrush dependent species, and people.

WHEREAS, the aforementioned government agencies continue to recognize and applaud the efforts of LWGs in conserving sage-grouse. Said agencies will continue to support these LWGs and their respective Plans, as they represent the heart of Idaho's sage-grouse conservation strategy.

I. AUTHORITIES

a. STATE AGENCIES:

Idaho State Department of Agriculture: Title 22, section 103 of the Idaho Code allows the ISDA to contract with any state agency, federal agency or agency of another state concerning any matter, program or cooperative effort within the scope and jurisdiction of the authority pursuant to law.

Idaho Department of Fish and Game: Title 36, section 1102 of the Idaho Code grants authority to IDFG to protect birds, including game birds like sage-grouse, in Idaho.

Idaho Department of Lands: IDL is directed by Article IX-Section 8 of the Idaho Constitution to manage the approximately 2.4 million acres of state endowment lands in such a manner as to secure the maximum long-term financial return to the institution to which granted. To the extent that it is consistent with this mandate, IDL has adopted a management policy that recognizes the value of wildlife and their habitats, and considers the impacts to wildlife habitat in management plans or projects. Where appropriate, IDL takes measures that protect or improve important and critical wildlife habitat, subject to the fundamental mission of IDL to support the endowments.

Office of Species Conservation: Title 67, section 818 of the Idaho Code allows the Governor's Office of Species Conservation (OSC) to negotiate agreements with federal agencies concerning endangered species, threatened species and candidate species. OSC is also responsible for coordinating the efforts of all state departments and divisions with duties and responsibilities affecting endangered species, threatened species and species to be listed.

b. FEDERAL AGENCIES:

Bureau of Land Management: The Federal Land Policy and Management Act (FLPMA, Sec. 307, 43 USC 1737) which provides overall direction to the BLM for conservation and management of the public lands, also allows the agency to participate in conservation agreements. BLM Manual, Section 6840 (Special Status Species Management) provides overall policy direction to BLM managers to conserve listed threatened or endangered species on BLM administered lands, and to ensure that actions authorized, funded, or carried out on BLM administered lands do not contribute to the need for federal candidate or BLM Sensitive species to become listed.

Forest Service: The 2005 planning rule, in part, establishes requirements for the sustainability of ecological systems, the goal of which is "*to provide a framework to contribute to sustaining native ecological systems by providing ecological conditions to support diversity of native plant and animal species in the area*" (36 CFR 219.10). Agriculture Department Regulation 9500-4 directs the U.S. Forest Service (USFS) to manage "*habitats for all existing native and desired non-native plants, fish, and wildlife species in order to maintain at least viable populations of such species*," and to "*avoid actions which may cause a species to become threatened or endangered*." USFS Manual section 2672.1 (Sensitive Species Management), directs national forests to provide special management emphasis for sensitive species of plants and animals to ensure their viability and to preclude trends toward endangerment that would result in the need for federal listing. Manual section 2672.12 allows regional foresters to enter into conservation agreements with the USFWS to remove threats to candidate species.

Natural Resources Conservation Service: The mission of the NRCS is to provide leadership in a partnership effort to help people conserve, maintain, and improve our natural resources and environment. Toward this end, NRCS is committed to improving biological resources by maintaining a high level of expertise in planning, using, and conserving soil, water, animals, plants, air, and related human resources. NRCS provides ecosystem-based assistance for the integrated management needed to sustain natural resources. Ecosystem-based assistance requires NRCS to use biological sciences to: 1) Develop and improve soil, water, animals, plants, air, and related human resources as integral components of all ecosystems, such as forest, range, cropland, and aquatic ecosystems, 2) Protect the habitat of threatened and endangered species of plants and animals and 3) Restore and safeguard unique ecosystems.

APHIS-Wildlife Services: Authority exists under the Act of March 2, 1931 (46 Stat. 1469; 7 U.S.C. 426-426b) as amended, and under the Rural Development, Agriculture, and Related Agencies Appropriations Act of 1988, (Public Law 100-202, 7 USC 426c) for APHIS-WS, acting under the Secretary of Agriculture, to conduct a program of wildlife services with respect to injurious animal species and to cooperate and enter into agreements with States, local jurisdictions, individuals, public and private agencies, organizations, and institutions in the control of nuisance mammals and birds and those mammal and bird species that are reservoirs for zoonosis diseases.

II. PURPOSE

The **purpose** of this MOU is to recognize the importance of the 2006 Conservation Plan for the Greater Sage-grouse in Idaho, as a backdrop for conserving sage-grouse in Idaho. In order to fully capture the value of said Plan, this MOU aims to illustrate the roles and responsibilities of the parties. Additionally, said MOU is intended to both emphasize the benefit contributed by the LWGs and encourage the efforts of the government agencies in supporting these vital groups.

The Parties herein also agree that increased cooperative efforts, consistent with applicable statutory requirements, LWGs and their respective Plans, and the State-wide Plan, are necessary to conserve sustainable healthy rangeland ecosystems to benefit sagebrush dependent species and the local economies that rely on them.

III. AGREEMENT PERIOD

This MOU shall be in effect when signed by all of the parties and remain in effect for five years. The MOU, however, may be extended or amended upon written request of any of the parties and the subsequent written concurrence of the others.

IV. RESPONSIBILITIES OF THE PARTIES

The Parties will coordinate activities and resources, when appropriate; however, the parties will control the expenditure of their own funds, in pursuing coordinated objectives.

Any costs borne by the parties under this MOU and any continuation thereof shall be contingent upon the availability of funds appropriated by the Congress of the United States or the Idaho Legislature.

V. OBLIGATIONS

a. STATE GOVERNMENT AGENCIES SHALL:

   i. Continue to support and recognize the important role of the LWGs and their respective plans in conserving sage-grouse;
      1. Consider and implement, to the extent possible, completed LWG plans as appropriate under agency regulations, policies and the law.

2. Actively participate, to the extent possible, in the planning and implementation of LWG goals and objectives outlined in their respective plans;
    a. Attend scheduled meetings and provide information to the LWG upon request;
    b. Make available to the LWG all relevant information regarding the management of sagebrush and sage-grouse habitats; and
    c. Cooperate with and provide advice to the LWG to the extent possible and consistent with the law, agency policy and regulations.
3. Continue to assist in the development and completion of new LWG plans, for areas where none currently exist, by providing the aforementioned services. IDFG will assume the lead role in initiating, coordinating, and maintaining functional LWGs.

ii. Implement, to the extent possible, the actions identified in the 2006 Conservation Plan for the Greater Sage-grouse in Idaho;
    1. Work collaboratively with the aforementioned federal government agencies, to the extent possible, in supporting the intent and actions identified in said Plan; and
    2. Work collaboratively through the Idaho LWGs, and other appropriate mechanisms, to support the intent and actions contained in said Plan.

b. <u>FEDERAL GOVERNMENT AGENCIES SHALL:</u>

i. Continue to support and recognize the important role of the LWGs and their respective plans in conserving sage-grouse;
    1. Consider and implement, to the extent possible, completed LWG plans as appropriate under agency regulations, policies and the law.
    2. Actively participate, to the extent possible, in the planning and implementation of LWG goals and objectives outlined in their respective plans;
        a. Attend scheduled meetings and provide information to the LWG upon request;
        b. Make available to the LWG all relevant information regarding the management of sagebrush and sage-grouse habitats; and
        c. Cooperate with and provide advice to LWG to the extent possible and consistent with the law, agency policy and regulations.

3. Continue to assist in the development and completion of new LWG plans, for areas where none currently exist, by providing the aforementioned services.

ii. Implement, to the extent possible, the actions identified in the 2006 Conservation Plan for the Greater Sage-grouse in Idaho;
    1. Work collaboratively with the aforementioned state government agencies, to the extent possible, in supporting the intent and actions identified in said Plan; and
    2. Work collaboratively through the Idaho LWGs, and other appropriate mechanisms, to support the intent and actions contained in said Plan.

VI. MODIFICATIONS

This agreement can be modified by the mutual, written consent of the parties at any time.

VII. CONGRESSIONAL RESTRICTIONS

Pursuant to Section 22, Title 41, United States Code, no member of or delegate to Congress shall be admitted to any share or part of this MOU or to any benefit to arise therefrom.

VIII. TERMINATION

This MOU may be terminated by any party upon sixty (60) days written notice to the other parties. The remaining parties can continue operating in accordance with the provisions of the MOU.

IX. ESTABLISHMENT OF RESPONSIBILITY

This MOU is not intended to, and does not create, any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity, by a party against the United States or the State of Idaho its agencies, officers, or employees.

Furthermore, this MOU does not necessarily validate or approve any specific LWG plan or recommendation. This MOU establishes the aforementioned agencies' commitment to continue to actively participate and cooperate with the LWGs, and consider LWG plans, as appropriate under the law and agency regulation.

X. NON-FUND OBLIGATING DOCUMENT

Nothing in this MOU shall obligate any of the parties to obligate or transfer any funds. Specific work projects or activities that involve the transfer of funds, services, or property among the various agencies and offices of the parties will require execution of separate agreements and be contingent upon the availability of appropriated funds. Such activities must be independently authorized by appropriate statutory authority. This MOU does not provide such authority. Negotiation, execution, and administration of each such agreement must comply with all applicable statues and regulations.

IN WITNESS WHEREOF, the parties hereto have executed this MOU as of the last date written below:

BUREAU OF LAND MANAGEMENT

By: _____ Date: _____
Bud Cribley, Acting State Director, Idaho BLM

FOREST SERVICE – INTERMOUNTAIN REGION

By: _____ Date: _____
Jack G. Troyer, Regional Forester,
Intermountain Region

IDAHO DEPARTMENT OF FISH AND GAME

By: _____ Date: _____
Steven M. Huffaker, Director

IDAHO STATE DEPARTMENT OF AGRICULTURE

By: _____ Date: _____
Patrick A. Takasugi, Director

IDAHO DEPARTMENT OF LANDS

By: _____ Date: _____
Winston A. Wiggins, Director

OFFICE OF SPECIES CONSERVATION

By: _____ Date: _____
James L. Caswell, Administrator

USDA NATURAL RESOURCES CONSERVATION SERVICE

By: _____ Date: _____
Richard W. Sims, Idaho State Conservationist

USDA-APHIS, WILDLIFE SERVICES

By: _____ Date: _____
Jeffrey S. Green, Western Regional Director

Chapter 1 – Introduction and Plan Overview

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1 Introduction and Plan Overview

1.1 Plan organization and overview

This Conservation Plan for the Greater Sage-grouse (*Centrocercus urophasianus*) in Idaho (henceforth referred to as Plan) includes six chapters and ten related appendices. This Plan has been developed to speak to diverse audiences and to fulfill a range of purposes. To facilitate use by a variety of audiences, this Plan is being produced as both a print and electronic document. In the electronic version of this document the individual chapters are available for download as separate PDF files. The electronic version of this document also contains hyperlinks to additional reference sources and materials. This Plan is intended to be a "living document," therefore, users may wish to check the associated web site at http://fishandgame.idaho.gov/cms/hunt/grouse/ periodically for any updates to the Plan.

In writing this Plan the authors used peer-reviewed documents reflecting the best available science wherever possible. However, in some cases non-peer reviewed documents were also referenced due to the limited availability of information for certain subjects.

Following is an overview of the Plan's organization and content:

- ***Chapter 1*** provides an overview of the rangewide and statewide context within which this Plan was developed. The goals and purposes of the Plan are presented and the conservation objectives are identified. This chapter also includes a summary of the processes that led to the development of this Plan as well as the ongoing development of Local Working Group (LWG) plans. Most importantly, Chapter 1 identifies how this Plan is intended to be used by new and existing LWGs as well as in areas where no LWGs currently exist. Chapter 1 also speaks to the relationship between existing LWG plans and this Plan. Finally, the Western Association of Fish and Wildlife Agencies (WAFWA) sage-grouse habitat management guidelines, and their use in the context of this Plan are briefly discussed in Chapter 1.

- ***Chapter 2*** provides a summary discussion of sage-grouse and sagebrush ecology. A basic understanding of both sage-grouse and sagebrush ecology are important components of planning for, designing, and implementing effective sage-grouse

conservation plans and projects. Those who wish to access additional information about sage-grouse and/or sagebrush ecology are directed in this chapter to other valuable informational sources.

- ***Chapter*** presents an overview of the status (at the time this Plan was completed) of sage-grouse habitat and populations in Idaho. This information is presented in this chapter at the mid-scale, Sage-grouse Planning Area (SGPA) level. Information included in this chapter includes a summary of land ownership, SGPA maps, SGPA population data and trends, and fragmentation analysis.

- ***Chapter*** consists of descriptions of 19 threats to sage-grouse and sage-grouse habitat, and provides a toolbox of conservation measures to address each of those threats.

- ***Chapter*** includes a discussion of research, monitoring and evaluation needs and recommendations. This chapter includes recommendations and methodologies for sage-grouse population monitoring and for habitat evaluation and monitoring. An overview of needed research and monitoring activities is also included. A discussion of adaptive management concludes this chapter.

- ***Chapter*** outlines the current implementation schedule for this Plan, that summarizes certain important tasks and target completion dates.

- ***ppe e*** to the Plan include: a definition of terms used in the Plan, a summary of sage-grouse petitions submitted to the U.S. Fish and Wildlife Service (as of May, 2004), the U.S. Fish and Wildlife Service 12-month Finding for three petitions to list the greater sage-grouse as threatened or endangered under the Endangered Species Act, the WAFWA Guidelines for Managing Sage-grouse Populations and Their Habitat, a summary of the January 2005 Idaho Science Panel threat prioritization and discussion, key sage-grouse planning contacts for Idaho, Idaho sage-grouse project ranking criteria, a booklet containing monitoring protocol guidelines, lek monitoring forms, a county MOU template, and the completed LWG plans.

1.1.1 Rangewide historical context

The greater sage-grouse has historically been, and continues to be an important species across the western rangelands which it inhabits. Centuries before European settlement of western North America, this bird was of ceremonial and subsistence significance to native peoples in the region. Recent excavations at the Bonneville Estates Rockshelter in Nevada suggest that humans began hunting sage-grouse, and depositing sage-grouse bones inside the shelter between 12,500 to 13,000 years ago, based on radiocarbon dating (Hockett 2005; B. Hockett, archaeologist, BLM Elko District, NV, personal communication, 9/6/2005).

Little is known about the population status of sage-grouse during the 19th century, though journal entries of certain explorers and naturalists describe encounters with the species. On June 5, 1805 Lewis and Clark first encountered the sage-grouse, at that time unknown to science, near the confluence of the Missouri and Marias Rivers in what today is central Montana. Lewis wrote, "*I saw a flock of the mountain cock, or a large species of heath hen with a long pointed tail which the Indians informed us were common to the Rockey [sic] Mountains…*" (Moulton and Dunlay 1987). On March 2, 1806, at Fort Clatsop near the mouth of the Columbia River, Clark wrote, "*the Heath Cock or cock of the Plains is found in the Plains of Columbia and are in great abundance from the enterance [sic] of Lewis's river [Snake] to the mountains which pass the Columbia between the Great falls and Rapids of that river*" (Moulton and Dunlay 1990).

In 1834, ornithologist John K. Townsend, encamped near the "Siskadee" or Green River in what is today, southwestern Wyoming wrote, "…*We have seen also another kind of game, a beautiful bird, the size of a half grown turkey, called the cock of the plains, (Tetrao urophasianus). We first met with this noble bird on the plains, about two days' journey east of Green river, in flocks or packs, of fifteen or twenty, and so exceedingly tame as to allow an approach to within a few feet, running before our horses like domestic fowls, and not unfrequently hopping under their bellies*…" (Townsend, J. K. 1839). For a more detailed discussion of the historical distribution of sage-grouse, see Schroeder et al. (1999).

By 1930 most land with potential for agricultural development was homesteaded and in private ownership (Braun 1998). Much of this land was planted to crops though some areas could not support crop production, and reverted to pastures or rangeland (Braun 1998). Settlement also brought ranches, mines, energy development, reservoirs, roads, fences, towns, power lines and vegetation treatments (Braun 1998). Invasive annual plant species, introduced near the end of the 19th century, also proliferated (Connelly et al. 2004). In the late 1940s, mechanical and chemical

control of vegetation were initiated on western rangelands, peaking in the 1950s and 1960's (Miller and Eddleman 2001). By the early 1960s, the elimination or reduction of sagebrush to increase grass production on public and private rangelands was common practice, affecting several million acres (Call 1979). Public concern for wildlife increased greatly during the 1970s (Call 1979).

Eventually, habitat losses and conversions approached, and in cases exceeded 50% in some areas (Dobler 1994, Braun 1998, Knick 1999). Schroeder et al. (2004) suggest that the area of distribution of greater sage-grouse currently occupies approximately 56% of the pre-settlement (pre-1800) distribution of potential habitat. In general, habitat loss, deterioration and fragmentation, are considered to be primary factors contributing to historical declines in sage-grouse abundance across their range (Connelly and Braun 1997, Schroeder at al. 2004).

Estimates of sage-grouse abundance prior to the late 1950s were mostly anecdotal, due a lack of systematic surveys (Braun 1998). Sage-grouse populations in the 1960s and 1970s were two to three times higher than current populations (Connelly et al. 2004). Eleven of 13 states and Canadian provinces showed significant long-term declines in size of active leks (maximum count of males present per lek) between 1965 and 2003. Eight of ten states showed significant population declines during that same time frame, however, the annual rate of decline was much greater between 1965 and 1985 (-3.5%) than between 1986 and 2003 (-0.37%). Some believe sage-grouse declines coincided with the abandonment of broad-scale predator control efforts in the 1970s. During the post-1986 timeframe, however, sage-grouse populations overall stabilized, and in some instances increased. On-going concerns remain over impacts to sage-grouse habitat, West Nile Virus, and other factors (Connelly et al. 2004).

Between May 1999 and December 2003, the U.S. Fish and Wildlife Service (USFWS) received eight petitions to list as endangered or threatened, various populations, purported subspecies, or species, of sage-grouse (Appendix B). In April 2004, USFWS determined that three of the petitions to list the greater sage-grouse as threatened provided substantial information that listing might be warranted, thus initiating a comprehensive range-wide status review. On January 7, 2005, a finding of *Not Warranted* was published in the *Federal Register*.

1.1.2 Cultural significance of the greater sage-grouse for the Shoshone-Paiute Tribes of southern Idaho

1.1.2.1 Tribal off-reservation traditional and treaty-reserved rights concerning sage-grouse

The Shoshone-Paiute Tribes of the Duck Valley Indian Reservation are protected by various treaties, Executive Orders, and laws in the matter of their interest in and reliance on the sage-grouse, among which are the following:

- Treaty With The Sho Sho Nee Nation Of Indians, 1855 (unratified)
- Treaty With The Eastern Shoshoni, 1863
- Treaty With The Shoshoni—Northwestern Bands, 1863
- Treaty With The Western Shoshoni, 1863
- Treaty With Mixed Bands Of Bannacks And Shoshonees, 1863 (unratified)
- Treaty With The Snake, 1865
- Treaty With The Eastern Band Shoshoni And Bannock, 1868
- Treaty With The Shoshones, Bannacks, And Sheepeaters, 1888 (unratified; see letter attached to treaty)
- Executive Order 12875, Enhancing the Intergovernmental Partnership
- Executive Order 13007, Indian Sacred Sites
- Executive Order 13084, Consultation and Coordination with Indian Tribal
- Governments
- National Historic Preservation Act
- National Environmental Policy Act
- American Indian Religious Freedom Act
- Archaeological Resources Protection Act
- Native American Graves Protection and Repatriation Act
- Department of Defense American Indian and Alaska Native Policy

The Shoshone-Paiute Tribes have never relinquished their land and continue to hold the aboriginal land title to much of their vast historical range, including lands throughout southern Idaho. Further, since November 15, 1985, it has been the announced, administrative policy of the Portland Area Office of the Bureau of Indian Affairs that tribal off-reservation treaty-reserved rights are potentially exercisable on all federal lands within a tribe's ceded area, as well as on federal lands in other areas traditionally used for those activities, unless applicable treaties/executive orders state otherwise. This is to be interpreted as acknowledging the reserved rights of the Shoshone-Paiute to access their traditional subsistence resources on public lands that are a part of their traditional homeland. These rights include hunting, fishing, performance of ceremonies and gathering culturally-important resources such as sage-grouse.

1.1.2.2 Spiritual Practices Concerning Sage-grouse

When discussing sage-grouse, or any other cultural resource, Shoshone-Paiute tribal members invariably point out the interconnectedness of the total environment. These interconnections go well beyond biological interactions to include medicinal, ceremonial, and spiritual interactions. In fact, virtually all resource procurement by the Shoshone-Paiute involves both spiritual as well as practical aspects. Sage-grouse, like other fauna, are believed to have spirits. The Creator, who is responsible for all things, intended them to be used by the Shoshone-Paiute people for subsistence and spiritual purposes.

The Shoshone-Paiute learn in early childhood a set of basic principles of proper behavior for using environmental elements. When an element such as sage-grouse is needed by the people, a reciprocal action from the people is necessary in return. Reciprocal actions are usually prayers and/or offerings that serve to confirm the need to take and use sage-grouse, to ask permission of the Creator to use it, and to give thanks to the Creator and the sage-grouse's spirit for its availability as a blessing to the people. The Creator has shown the people how He wants resources to be used, so prayers and offerings are also a form of acknowledging that the sage-grouse is being treated according to His intentions.

Offerings are usually token gifts such as a pretty ribbon tied on a tree to decorate it, or small objects left at the site of resource procurement, such as tobacco or coins. Prayers are given at the time a resource is removed from the environment as well as when it is used. Tribal members often phrase this as "taking care of" or "being respectful of" the environment. Prayers include a statement of need (for what purpose a resource will be used) and wishes of good health and well-being both for the resource and for the people who depend on it. In cases where a plant or animal such as the sage-grouse must be killed to be used as a resource, prayers also help its spirit through a regenerative process. One Tribal elder stated this process succinctly:

> *When [a sage-grouse] is killed during hunting, tobacco or some other offering is left, and prayers are said to help [its] spirit get safely to the spirit world and so that the Creator would establish another one of those beings here and keep them plentiful. The prayer is both to the [sage-grouse's] spirit and to the Creator. It is done because you have taken something you need to survive, and it helps re-establish the harmony.*

Such reciprocal actions are believed to nourish the sage-grouse and assure that it will continue to be available and be nourishing to the people in the future.

"**Song of the Sage Hen**"[1]

Sage Hen landing on a mountain pass
Migrating around
Migrating around
Sage Hen landing on a mountain pass
Migrating around
Migrating around
Walks around there
On warm white sand
Walks around there
On warm white sand

To the Tribes sage-grouse, also known as Hoojah or Hoocha, are medicine birds. The males impart to certain tribal members a spirit of divination, making the possessor a medicine man with powers of healing, divination and exorcism. While this has been described in various publications that speak of the spiritual powers of sage-grouse in the past, this power can still be obtained from the sage-grouse, according to Shoshone-Paiute spiritual leaders. Sage-grouse and their leks are still honored by the Shoshone-Paiute Tribes in various ceremonies and sacred dances.

1.1.2.3 Subsistence reliance and practices concerning sage-grouse

As a subsistence resource, sage-grouse have multiple traditional uses. Depending upon the season, sage-grouse have been traditionally used as food, in clothing, as manufacturing materials, as food for other animals, as archetypes in stories and legends, in making toys and musical instruments, in ceremonial costumes, to assist prayers on their journeys, and as omens. Sage-grouse can be an important source of meat, a staple in the Shoshone-Paiute diet that is available nearly year-round. In early summer and between major salmon and steelhead adult returns, the Tribes dispersed into family units to hunt sage-grouse, while simultaneously gathering seeds, berries, and roots. Sage-grouse eggs are also important in diets, as are the eggs of various other bird species. Sage-grouse feathers are used in fans, on ceremonial costumes, and are preferred as fletching for arrows. Their bones are used for ceremonial whistles which helped prayers ascend to the spirits. Dances, regalia, and observances

[1] Newe Hupia: Shoshoni Poetry Songs. Beverly Crum, Earl Crum, and Jon P. Dayley. Logan: Utah State University Press.

celebrate the bird's place in Shoshone-Paiute culture and society. The sage-grouse is, in some respects, honored as much as the eagle.

Tribal members assert that sage-grouse leks must be protected because they are sacred. Many leks have been used for generations, while the use of some leks extended indefinitely into the past. Further, leks are often present around buttes and rimrocks, which is significant because the Tribes recognize that buttes and rimrocks have their own sanctity, and the presence of sage-grouse adds another level of sacredness to these significant areas.

Various proposals have been advanced for perimeters of protection around leks that extend outward for up to 5 miles, which tribal members believe are necessary for their protection. This is needed in part because the Tribes have noted that leks used for an extended period of time tend to be those that avoid excessive human or cattle-related disturbances. Consequently, actions must be taken to protect culturally-important habitat (including lek and nesting habitat) that the Tribes and sage-grouse depend on for their ongoing existence.

1.1.3 Cultural significance of the greater sage-grouse to the Shoshone-Bannock Tribes

Since time immemorial, the Shoshone and Bannock people have relied on the sagebrush steppe ecosystem to provide flora and fauna for subsistence needs. Prior to westward expansion, the sagebrush steppe ecosystem was vast, contiguous and unimpaired by man-made threats. The Shoshone and Bannock people consider the greater sage-grouse, a sagebrush steppe obligate, a staple for subsistence and ceremonial purposes. Today, the Shoshone-Bannock Tribes continue to utilize sage-grouse and are concerned about their ability to exist under current management conditions and the impacts that their demise would have on Tribal culture and traditions

The sage-grouse is significant in the Shoshone and Bannock cultures. The tangible significance of sage-grouse is illustrated in tribal traditional dance, sustenance and ceremonial songs. The intangible significance is evident in the spiritual belief associated with sage-grouse. The Chicken Dance is a traditional dance that honors the sage-grouse. This traditional dance imitates the dance the grouse performs during the mating season. The dancers' regalia reflect the image of the grouse in the headdress, bustle and whistle. The grouse is also a traditional sustenance resource and is a part of the traditional diet of the Shoshone Bannock Tribes. On a broad cultural scale the sage-grouse spiritual significance is observed in the acknowledgement that sage-grouse is a part of the web of life and plays an important

role in maintaining balance of life. Specifically the sage-grouse spiritual importance is recognized in the songs sung in traditional ceremonies which speak of the power the sage-grouse possesses.

1.1.3.1 Off-Reservation Reserved Treaty Rights of the Shoshone-Bannock Tribes

On July 3, 1868, the Fort Bridger Treaty was entered into between the Shoshone-Bannock Tribes and the United States. Article IV of the Fort Bridger Treaty reserved off-reservation rights of the Shoshone-Bannock Tribes, specifically the right to hunt on unoccupied lands of the United States. The Fort Bridger Treaty provided for a unique relationship between the Tribes and the United States and created a formal trust responsibility to the Tribes. Under this obligation the United States has a special fiduciary responsibility to consider the best interests of the Shoshone-Bannock Tribes pursuant to the Fort Bridger Treaty. Today, most fundamentally, the modern form of the trust obligation is the federal government's duty to protect Indian lands and treaty resources, including the off-reservation rights the Tribes reserved. This duty to protect treaty resources includes preserving the integrity of lands upon which the resources are located

1.1.4 Idaho historical context

In the State of Idaho, the sage-grouse has been a species of interest for well over a century, providing food, recreational, and research opportunities for Idaho's citizens. Moreover, for centuries, the sage-grouse has also been important to the region's American Indian Tribes for ceremonial and subsistence reasons. It remains an important part of the sagebrush community and is sometimes used as a measure of sagebrush ecosystem health. The Idaho Bird Conservation Plan (Idaho Partners in Flight 2000) utilizes the sage-grouse as an umbrella species, in helping describe general objectives for sagebrush habitats. The sage-grouse was selected for this role since it is a sagebrush obligate, has a relatively large home range incorporating expanses of sagebrush habitat, and its habitat requirements are assumed to encompass those of many other sagebrush obligate avian species. Additional discussion regarding the utility of sage-grouse as an umbrella species can be found in Rowland et al. (2005).

Historical populations of sage-grouse in Idaho are not well documented. Before 1900 sage-grouse were not protected in Idaho. The first Idaho sage-grouse hunting season

was established in 1900 (Autenrieth 1981).[2] Over the years Idaho's hunting seasons have varied greatly from three month seasons with a 15-20 bird bag in the early 1900s, to closed seasons for 21 of the 31 years from 1918 to 1948. As early as the 1920s, wildlife managers voiced concerns about the future of Idaho's sage-grouse populations. In a trend mirroring that seen in other western states, Idaho has experienced substantial alteration and losses of sagebrush steppe habitat since European settlement.

Drought conditions during the late 1980s through the early 1990s, which resulted in amplified pressures on shrub steppe ecosystems, in concert with continued declines in Idaho's sage-grouse populations, served to heighten concerns among local resource managers. Concerns regarding sage-grouse habitat and/or population trends also resulted in the species designation as Sensitive by Idaho Bureau of Land Management (BLM) and U.S. Forest Service (USFS) Region 4. Broad-scale monitoring of sage-grouse populations did not begin until the 1960s. Statewide, sage-grouse populations in Idaho showed an overall declining trend between 1965-2003 (Figure 1-1).

[2] The impetus for establishing this initial hunting season was to prohibit spring shooting during critical reproductive periods.

Figure 1-1 Change in the population index for greater sage-grouse in Idaho, 1965-2003 (Connelly et al. 2004)[3]

1.1.5 U.S. Fish and Wildlife Service 2005 Finding

On January 12, 2005, the USFWS announced the results of their 12-month Finding for three petitions to list the greater sage-grouse as threatened or endangered under the Endangered Species Act (USDI-FWS 2005). After reviewing the best available scientific and commercial information, they found that listing, at this time, is not warranted (Appendix C).

In the Finding the USFWS stated, "*Although sagebrush habitat continues to be lost and degraded in parts of the greater sage-grouse's range (albeit at a lower rate than historically observed), from what we know of the current range and distribution of the sage-grouse, its numbers are well represented. As a result, we find that the species is*

[3] The population index (irregular line) was derived from changes in counts of males on the same leks between consecutive years. The regression (dashed) line illustrates the overall downward trend from 1965-2003. For a detailed discussion of the process used in this analysis, see Connelly et al. (2004) pages 6-18 through 6-21. Pages 6-30 through 6-33 of Connelly et al (2004) discuss Idaho sage-grouse population trends in additional detail.

not in danger of extinction, nor is it likely to become endangered in the foreseeable future. We are encouraged that sage-grouse and sagebrush conservation efforts will moderate the rate and extent of habitat loss for the species in the future. We strongly encourage the continuation of these efforts" (USDI-FWS 2005).

The Endangered Species Act requires the USFWS to make a decision based on what is known at the time of listing. In the Finding the USFWS noted, "*the future health of both the sagebrush system and sage-grouse depends on how threats are expressed and how managers respond to them in the next 5 to 20 years*" (USDI-FWS 2005).

1.2 Goals and purposes of Plan

1.2.1 Goals

The primary goal of this Plan is to:

1. Maintain, improve, and where possible, increase sage-grouse populations and habitats in Idaho, while considering the predictability and long-term sustainability of a variety of other land uses.

Secondary goals of this Plan include:

2. Establishing broadly representative LWGs in all SGPAs that currently lack them;

3. Fostering and supporting effective LWGs and their activities, throughout the range of sage-grouse in Idaho;

4. Fostering and supporting completion of LWG plans for all of Idaho's SGPAs; and,

5. Fostering and supporting effective coordination among state and federal agencies, Tribes, and non-governmental cooperators to achieve the primary goal of this Plan.

This Plan is intended to be a **"living document"** that will be periodically updated and/or amended as appropriate (e.g., as new information becomes available, regional and local conditions change, new technologies or techniques become available, additional LWGs complete their local plans and contribute to increased refinement of local site-specific data and information).

1.2.2 Purposes

The overarching purpose of this Plan is to:

1. Effectively conserve Idaho sage-grouse populations and sagebrush communities through support of individual and collective efforts of LWGs, non-governmental organizations, local governments, state and federal agencies, Tribes, and members of the public. The Plan provides those individuals and entities with guidance, information, conservation tools, and related resources necessary to achieve locally and regionally appropriate conservation objectives.

Additional purposes of this Plan include:

2. Development of a framework that will encourage and promote greater consistency among Idaho's LWG plans (e.g., more standardized organizational structure and terminology) as they work to eliminate, reduce or mitigate threats to sage-grouse and sage-grouse habitat.

3. Integration, to the extent possible, of national, regional, and local knowledge and management objectives, in order to effectively conserve sage-grouse populations and sagebrush communities.

4. Provide for effective coordinated management across jurisdictional boundaries by fostering mechanisms and agreements to coordinate the efforts of: state agencies, federal agencies, and Tribes, with non-governmental individuals and organizations -- to cooperatively implement conservation measures for the sage-grouse and sage-grouse habitats within Idaho.

5. Acknowledge and respect the different perspectives, interests, and legal mandates of wildlife professionals, land managers, Tribes, non-governmental organizations, private landowners, and all others who share a stake and interest in sage-grouse and sagebrush steppe communities.

1.3 Conservation objectives

Given the distribution of sage-grouse across the Idaho landscape, migratory nature of certain sage-grouse populations, variety of seasonal habitats required, complexity of land ownership patterns, and magnitude of certain threats (e.g., wildfire, invasive annual grasses), the long-term viability of sage-grouse in Idaho is dependent on developing and implementing conservation measures across a range of scales.

Focusing efforts primarily at the fine-scale (project, site-specific) may overlook cumulative impacts and important landscape issues such as connectivity between sage-grouse population strongholds, or may divert limited funding from higher priorities in Idaho. Conversely, conservation efforts focused primarily at the mid- or broad-scale may neglect crucial site-specific circumstances or needs. In seeking to understand and address the complex interactions of factors influencing habitat quality and sage-grouse populations, managers should, whenever possible, look across multiple scales. Local working groups should develop and/or adopt local goals and objectives.

For the purposes of this Plan the broad-scale is defined as the State of Idaho (i.e., approximately 1:500,000-plus scale), mid-scale is defined as the Sage Grouse Planning Area (i.e., approximately 1:100,000 scale), and fine-scale is defined as the watershed and/or specific project scale (i.e., approximately 1:24,000 scale).

1.3.1 Population objectives

The following population objectives apply to the broad-, mid-, and fine-scales:

1. Maintain, and increase where possible, the present distribution and abundance of sage-grouse in Idaho.

2. Reduce, eliminate, or mitigate the adverse impacts of human-related or unnatural disturbance to sage-grouse within or near breeding and winter habitat throughout Idaho.

1.3.2 Habitat objectives

The following habitat objectives apply to the broad-, mid-, and fine-scales:

1. Maintain, enhance or restore sage-grouse habitat, and continuity of habitats, at multiple spatial scales.

2. Manage Idaho's landscape to foster a dynamic sagebrush ecosystem that includes a diverse species composition of sagebrush, grasses, and forbs; and incorporates structural characteristics that promote rangeland health in general, and sage-grouse habitat requirements in particular.

In addition to the broad conservation objectives identified above, following are specific broad-, mid- and fine-scale sub-objectives.

1.3.2.1 Broad-scale habitat sub-objectives

- Foster the maintenance or recovery of rangewide sage-grouse populations in a manner that complements similar efforts in adjacent states.

- Collaborate with states that share contiguous sage-grouse habitats to maintain, enhance or restore sage-grouse habitat.

1.3.2.2 Mid-scale habitat sub-objectives

- Manage sagebrush so that it is well distributed on the landscape, as ecological site conditions allow. Emphasis should be placed on maintaining or restoring large contiguous core areas or blocks of sagebrush that have the necessary species and age diversity of sagebrush and herbaceous components to produce sustainable sage-grouse habitat. The primary long-term objective is to ensure adequate areas within each SGPA suitable for meeting all seasonal habitat needs of sage-grouse and the sage-grouse population and distribution goals of this Plan. Using the 2004 sage-grouse Habitat Planning Map as a preliminary guide (See SGPA maps located in Chapter 3), maintain, enhance or restore existing key and stronghold sage-grouse habitat across SGPAs.

- Maintain smaller islands, corridors, or mosaic patterns when provision for large, extensive blocks of sagebrush is not feasible or appropriate due to ecological site limitations (e.g., mountainous areas with complex topographic features, sagebrush patches intermingled with forested cover types).

- Enlarge existing stronghold habitats.

- Establish or improve connectivity and genetic interchange between populations by re-establishing suitable habitat in intervening areas.

- Enhance habitat quality and quantity in isolated population areas to enhance population sustainability.

- Increase the proportion of key and stronghold habitat in SGPAs by (1) diversifying structural and species composition and re-establishing sagebrush within large perennial grass seedings, (2) rehabilitating annual exotic

grasslands, (3) managing conifer encroachment to restore sage-grouse habitat (4) improving understory habitat quality in areas where sagebrush cover limits the herbaceous cover needs of sage-grouse, (5) improving understory quality where sagebrush cover is otherwise suitable.[4]

1.3.2.3 Fine-scale sub-objectives

In addition to the appropriate broad- and mid-scale objectives identified above, fine-scale conservation objectives will be identified within each of the LWG plans once completed. The following objectives are also intended to serve as interim objectives in areas where LWG plans are not yet complete or where no LWG currently exists.

- Promote rangeland health and vegetation characteristics (e.g., species diversity including big sagebrush and other sagebrush species, perennial herbaceous cover, forbs, etc.) at the fine-scale that contribute to mid-scale objectives.

- Coordinate with appropriate agencies to map and monitor sage-grouse seasonal habitats (preferably at the population scale if known) to facilitate conservation planning, aid in the prioritization of habitat-improvement and restoration projects, and document the effectiveness of projects or management changes.

- Agencies will collaborate to understand the cumulative effects of management decisions.

- Projects and management actions should contribute to the maintenance, restoration, or rehabilitation of sage-grouse habitats.

1.4 Development of the Idaho Plan and Local Working Group plans

For all of the parties involved in sage-grouse conservation and planning efforts across the state of Idaho, there has been, and continues to be an ongoing learning process relative to: sage-grouse habitat and sage-grouse requirements, changing conditions and priorities across the landscape, effectiveness of various approaches to planning and development of LWG plans, and evolving tools and resources. This document reflects, and is also an artifact, of that fluid and dynamic process.

[4] Note: items 4 and 5 assume sagebrush is not otherwise limiting on the landscape.

1.4.1 1997 Idaho Plan

In 1997, the Idaho Sage-grouse Task Force, under direction of the Idaho Fish and Game Commission, completed the Idaho Sage-grouse Management Plan (IDFG 1997). The 1997 Plan subdivided Idaho into 13 sage-grouse management areas. These management areas reflected sage-grouse populations or groups of populations by discrete geographic areas in Idaho based on readily definable boundaries, administrative jurisdictions, and current information.

Subsequently, six sage-grouse LWGs were formed to assist in local sage-grouse planning and management efforts in selected areas of Idaho. A seventh group, previously established in Shoshone Basin in 1994, was also adopted as a LWG. The original LWG boundaries in most cases overlapped one or more of the original sage-grouse management areas.

1.4.2 Current and ongoing planning efforts

Planning for sage-grouse conservation has continued to evolve in Idaho since 1997. The preliminary planning efforts focused mostly on what were identified as priority areas. To ensure that all areas of Idaho that harbor sage-grouse habitat are eventually addressed, and to further statewide and local conservation efforts, the original 13 management areas were reconfigured into 13 SGPAs.

These 13 revised SGPAs (Figure 1-2) form the geographic foundation for mid-scale sage-grouse conservation planning and for the efficient marshalling of conservation resources. Although these new planning areas deviate somewhat from the original sage-grouse management areas described in the 1997 plan, they correlate directly with existing LWG area boundaries.

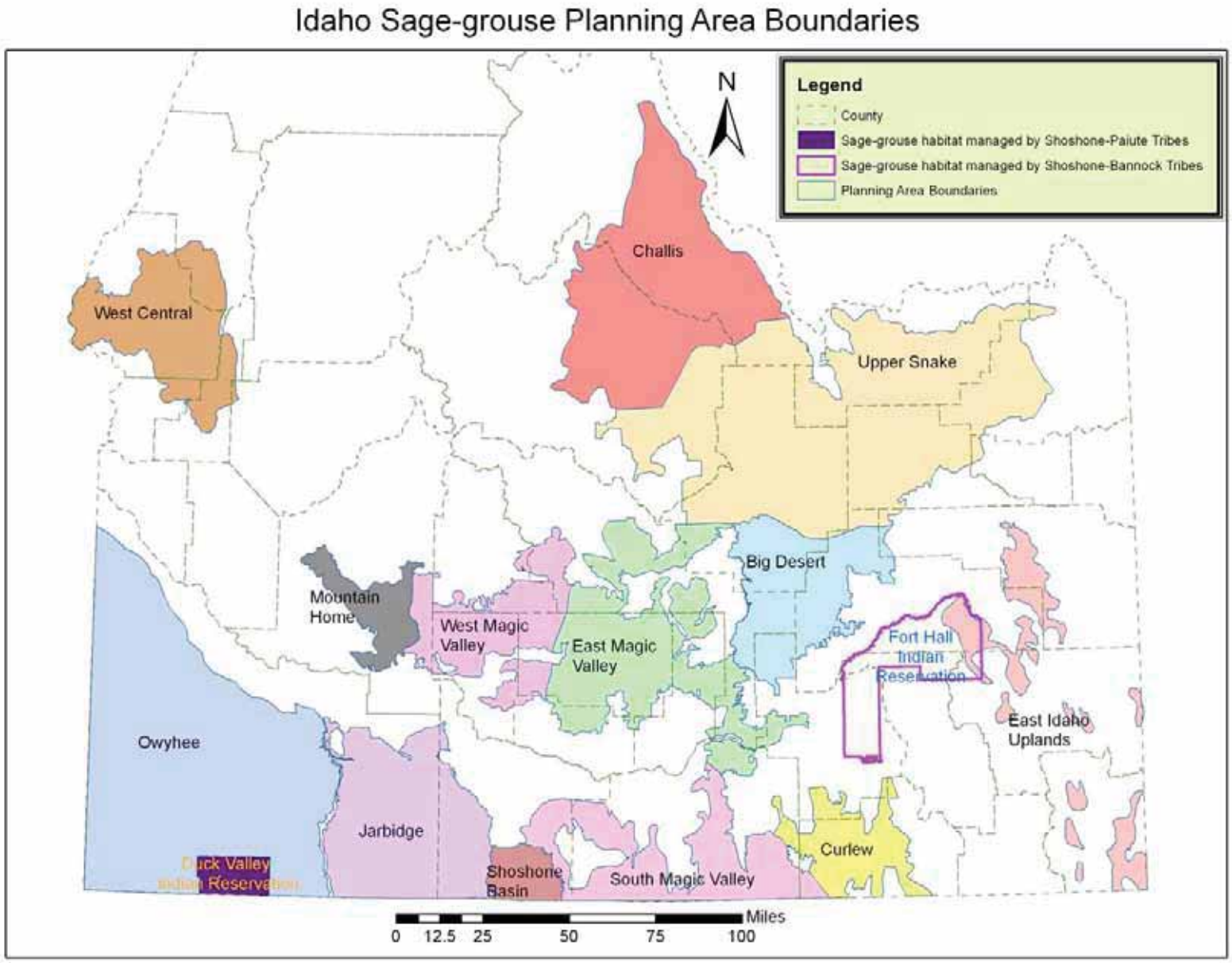

Figure 1-2 Idaho Sage-grouse Planning Areas.

In 2003, the Director of the Idaho Department Fish and Game appointed the Idaho Sage-grouse Advisory Committee (SAC). In addition to representatives from key agencies, this committee includes private citizens from agricultural and conservation groups and at least one member from each Local Working Group. In addition to improving communication between LWGs and advising the state on how to distribute federal grant funds, the SAC has assisted in updating the 1997 plan.

As of December 31, 2005 two LWG plans have been completed, and three are nearing completion (Table 1-1). The development of new LWGs in areas without them, and completion of LWG plans for those areas is a priority of this Plan.

Table 1-1 Status of LWGs and LWG Plans by SGPA

SGPA	LWG Status[5]	LWG Plan Status[6]
Big Desert	None at this time	None at this time[7]
Challis	Started 2002	In development
Curlew	Started 1998	Completed
East Idaho Uplands	None at this time	None at this time[6]
East Magic Valley	None at this time	None at this time[6]
Jarbidge	Started 1999	Draft complete
Mountain Home	None at this time	None at this time
Owyhee	Started 1998	Completed
Shoshone Basin	Started 1994	Draft complete
South Magic Valley	None at this time	None at this time[6]
Upper Snake River	Started 1998	Completed
West Central	Started 2004	In development
West Magic Valley	None at this time	None at this time[6]

1.4.3 Relationship between Local Working Group plans and state Plan

The state Plan identifies threats at the broad-scale, while also providing a toolbox of mid- and fine-scale conservation measures for use and/or adaptation by LWGs (as appropriate to local population and habitat conditions), and for use in cases where a LWG plan has not been completed, or where no LWG currently exists. The LWG

[5] As of December 31, 2005.

[6] As of December 31, 2005.

[7] In 2004, IDFG Regions, in cooperation with local partners, began identifying conservation issues for the Big Desert, East Idaho Uplands, East Magic Valley and West Magic Valley SGPAs, to aid in the preparation for the eventual establishment of LWGs in these areas. The South Magic Valley SGPA began preliminary discussions during 2005.

plans will identify threats and appropriate conservation measures at the mid-and fine-scale.

This state Plan is designed to provide guidelines and specific recommendations intended to promote a level of consistency (e.g., identification of range of threats, standard terminology, format, etc.) among LWG plans.

The state Plan and the LWG plans are expected to be "living documents," as new information becomes available, and/or techniques and technologies improve, the plans should be updated or revised.

1.4.3.1 Local Working Group Plans

The purpose of LWG plans is to increase sage-grouse populations and/or improve sage-grouse habitat within the Plan's boundary, while considering the predictability and long term sustainability of a variety of other land uses. The LWG plans should identify potential threats and provide recommended actions to mitigate those threats, benchmarks for completing those recommended actions, and monitoring protocols to address those threats that are affecting sage-grouse or their habitat within the LWG boundary.

The LWG plans provide the guidance that agencies, businesses, and individuals should consider when performing actions in sage-grouse habitats. In general, the expectation is that when sage-grouse concerns arise at the local level, LWGs, agency representatives, landowners, and others will look first to the appropriate LWG plan for specific guidance. If a LWG plan is silent on the issue of concern, parties would look next to the state Plan for guidance. The LWGs are expected to work with, and through, the appropriate federal and state agencies, landowners, and regulatory processes to implement the conservation measures/actions identified in their LWG plans to reduce, eliminate, or mitigate identified threats to sage-grouse and sage-grouse habitat

1.4.3.2 The Conservation Plan for the Greater Sage-grouse in Idaho

The goal of the Conservation Plan for the Greater Sage-grouse in Idaho is to maintain, improve, and where possible, increase sage-grouse populations and habitats in Idaho, while considering the predictability and long-term sustainability of a variety of other land uses.

Some geographic areas in Idaho do not have active LWGs. The Conservation Plan identifies statewide threats and a toolbox of conservation measures to address those threats.

The Conservation Plan will also serve as a useful reference tool to support all LWGs as well as areas without LWGs by:

- providing background information and resources regarding sage-grouse and sagebrush ecology;
- providing an overview of sage-grouse populations and sage-grouse habitats within the state;
- discussing threats at a state wide level;
- providing a toolbox of conservation measures which may be used by LWGs;
- discussing the data and research needs that would lead to a better understanding of sage-grouse and sage-grouse habitat; and
- providing protocols for monitoring and evaluation of sage-grouse populations and sage-grouse habitats.

By providing these various resources for consideration by LWGs, the Plan encourages a level of consistency among the LWG plans and actions.

All completed LWG plans will be incorporated as appendices to this Plan.

The most recent update of this Plan and each of the most recent version of the completed LWG plans will also be located together at http://fishandgame.idaho.gov/cms/hunt/grouse/ along with links to a selection of relevant informational resources.

1.4.4 Relationship to other planning efforts and regulations

Federal agencies administer roughly 73% of existing sagebrush lands in Idaho. State and private lands comprise an additional 7% and 19%, respectively. Complicating matters, the interspersion and continuity of land ownership patterns varies widely across Idaho; from large, contiguous acreages of federal and state lands in the

southwestern part of the state to more fragmented or mosaic patterns of federal, state, and private lands in the south-central and eastern portions.

In addition to collaborative efforts within Idaho, coordination between Idaho and adjoining states will be necessary. The primary mechanisms for interstate coordination include the 1999 Memorandum of Understanding between member states comprising the Western Association of Fish and Wildlife Agencies (WAFWA), and the 2000 Memorandum of Understanding between WAFWA and the U.S. Forest Service, BLM, and USFWS. The 1999 MOU is currently under revision. A range-wide sage-grouse conservation strategy, also currently under development, will help guide these collaborative interstate efforts and will provide recommendations for more specific eco-regional conservation measures.

Parties to this Plan recognize that in some instances, federal and state agencies may need to formalize conservation measures or other actions through additional processes separate from this Plan, such as resource management plan amendments, terms and conditions, or other means including compliance with National Environmental Policy Act requirements or state law.

1.4.5 Authorities and missions

In implementing this Plan, a variety of multi-disciplinary expertise will be required. Resource users may have an intimate knowledge of local conditions, can sometimes provide innovative solutions to problems, and can contribute an important historical perspective. Agency personnel have expertise in monitoring and managing wildlife populations and habitats and generally have at their disposal state of the art technical equipment and procedures.

Cooperating agencies and organizations that will participate in the implementation of this Plan are themselves governed by specific legal mandates, responsibilities, and/or mission statements related to their respective involvement in conservation issues or conservation planning.

Following is a summary of the authorities and the mission statements of the various entities that have participated in development of this Plan and who will participate in the implementation of this Plan, and many LWG plans.

1.4.5.1 Local Working Groups

The LWGs are the heart of Idaho's sage-grouse conservation strategy, and are critical to the successful implementation of this plan. To be successful, the LWGs will need to represent a broad range of interests affected by, and concerned with, sage-grouse management and populations. Membership should include, but is not limited to, local land-owners; members of the public; non-governmental organizations; representatives of industry; local government; state and federal agencies; and American Indian Tribes. LWGs that represent a broad range of interests and perspectives ensure a diverse base of support for LWG proposed projects or actions. For example, if projects proposed by a LWG have broad public support they are less likely to be challenged. LWGs may also provide valuable input to inform and potentially improve agency decision-making.

The collaborative development of broadly-represented LWG plans is vital to successful execution of those plans through identification of local threats and appropriate conservation actions, project identification and implementation, contribution to monitoring and evaluation activities, and periodic updating of the LWG plans. As participants on the LWGs, state, federal and Tribal representatives are expected to keep LWG members apprised of any conflicting legal mandates or concerns as the local plans are in development.

1.4.5.2 Federal agencies

1.4.5.2.1 U.S. Bureau of Land Management

The Federal Land Policy and Management Act, or FLPMA, which provides overall direction to the U.S. Bureau of Land Management (BLM) for the conservation and management of public lands, also allows the agency to participate in cooperative agreements (43 USC 1737 Sec. 307b). BLM Manual section 6840 (Special Status Species Management) requires that actions authorized on BLM-administered lands do not contribute to the need to list federal candidate or Bureau sensitive species under provisions of the Endangered Species Act.

The land use planning process, mandated by FLPMA and described in the regulations at 43 CFR 1610, is used to identify desired outcomes (goals and objectives) and allowable uses and actions anticipated to achieve desired outcomes on BLM-administered lands. BLM's planning process will develop management direction consistent with the Idaho Conservation Plan for the Greater Sage-grouse and integrated across all resource uses.

BLM Fundamentals of Rangeland Health and Standards and Guidelines for Grazing Administration (43 CFR Subpart 4180), in part, require the management of rangelands to ensure that "*Habitats are, or are making significant progress toward being, restored or maintained for Federal threatened and endangered species, Federal Proposed…and other special status species*" (43 CFR 4180.1).

In Idaho, 43 CFR 4180 is implemented through the Idaho Standards for Rangeland Health and Guidelines for Livestock Grazing Management, adopted August 1997 (USDI-BLM 1997). Where appropriate on the landscape, Idaho BLM rangelands are expected to meet eight Standards for Rangeland Health or should be making significant progress toward meeting the standards. Standard 8, which requires that "*Habitats are suitable to maintain viable populations of threatened and endangered, sensitive and other special status species*", is of particular relevance to sage-grouse.

BLM has developed a National Sage-Grouse Habitat Conservation Strategy (USDI Bureau of Land Management, 2004). The purpose of the comprehensive National Sage-grouse Strategy is to set goals and objectives, assemble guidance and resource materials, and provide a comprehensive management direction for the BLM's contributions to on-going multi-state sage-grouse conservation effort in cooperation with WAFWA. Implementation of BLM's National Sage-grouse Strategy and the state level Sage-grouse Conservation Strategies will complement and expand the ongoing efforts to conserve sagebrush ecosystems on public lands administered by the BLM for the benefit of sage-grouse and other wildlife species.

1.4.5.2.2 U.S. Department of Agriculture, Natural Resources Conservation Service

The mission of the Natural Resources Conservation Service (NRCS) is to "*provide leadership in a partnership effort to help people conserve, maintain, and improve our natural resources and environment*." Toward this end, NRCS is committed to improving biological resources by maintaining a high level of expertise in planning, using, and conserving soil, water, animals, plants, air, and related human resources. NRCS provides ecosystem-based assistance for the integrated management needed to sustain natural resources. Ecosystem-based assistance requires NRCS to use biological sciences to: 1) develop and improve soil, water, animals, plants, air, and related human resources as integral components of all ecosystems, such as forest, range, cropland, and aquatic ecosystems; 2) protect the habitat of threatened and endangered species of plants and animals; and 3) restore and safeguard unique ecosystems.

1.4.5.2.3 U.S. Fish and Wildlife Service (Technical Advisors on Plan)

The U.S. Fish and Wildlife Service is a bureau within the U.S. Department of the Interior. Its mission is, "*working with others, to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.*" While not a formal party to this Plan, U.S. Fish and Wildlife Service has had ongoing representation on the SAC, and has provided helpful perspectives during the preparation of portions of this Plan.

1.4.5.2.4 U.S. Forest Service

The 2005 planning rule, in part, establishes requirements for the sustainability of ecological systems, the goal of which is "to provide a framework to contribute to sustaining native ecological systems by providing ecological conditions to support diversity of native plant and animal species in the plan area" (36 CFR 219.10). Agriculture Department Regulation 9500-4 directs the U.S. Forest Service (USFS) to manage "habitats for all existing native and desired non-native plants, fish, and wildlife species in order to maintain at least viable populations of such species," and to "avoid actions which may cause a species to become threatened or endangered". USFS Manual section 2672.1 (Sensitive Species Management) directs national forests to provide special management emphasis for sensitive species of plants and animals to ensure their viability and to preclude trends toward endangerment that would result in the need for federal listing. Manual section 2672.12 allows regional foresters to enter into conservation agreements with the USFWS to remove threats to candidate species.

1.4.5.2.5 U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services

The Animal and Plant Health Inspection Service (APHIS) is an agency under the U.S. Department of Agriculture, and the Wildlife Services program is one of several programs in APHIS. Under the authority of the Animal Damage Control Act of 1931, Wildlife Services provides Federal leadership and expertise in addressing a wide range of conflicts between humans and wildlife. Part of this role involves providing assistance to other agencies and the public in addressing wildlife damage to natural resources. This Plan and some of the LWG plans have identified predation as one of the multiple potential threats to sage grouse, and Wildlife Services can provide expertise and assistance in dealing with predation concerns at the local level.

1.4.5.3 American Indian Tribes

The United States has a unique legal relationship with American Indian Tribes as set forth in the Constitution of the United States, treaties, statutes, Executive Orders, and court decisions. The Federal Government has enacted numerous regulations and policies that further establish and define a trust relationship with Indian tribes.

All federally-recognized American Indian Tribes have off-reservation interests in public lands and many retain pre-existing rights reserved through treaty or executive order language. The legal basis of these tribal rights and interests are founded in the inherent sovereignty of American Indian Tribes; continuing aboriginal rights; pre-existing rights reserved in treaties, executive orders; agreements; and federal statutes.

The relationship between Federal agencies and American Indian Tribes is defined by numerous laws and regulations addressing the requirement of Federal agencies to notify or consult with American Indian Tribes, or otherwise consider their rights and interests, when planning and implementing Federal undertakings. As such, federal land managing agencies participating in the Idaho's sage-grouse conservation Plan will work closely with American Indian Tribes through the government-to-government consultation process to appropriately address tribal rights and interests.

Sage-grouse have significant cultural importance to American Indian Tribes and must be considered in relation to the associated rights and interests American Indian Tribes have on federally-administered lands. In conservation planning and project development and implementation efforts for sage-grouse or their habitat occurring on federal lands, federal land managing agencies will ensure tribal involvement through the government-to-government consultation process.

1.4.5.4 State agencies

1.4.5.4.1 Idaho Department of Fish and Game

Idaho Code, Section 36-103 states, "*All wildlife, including all wild animals, wild birds, and fish within the State of Idaho is hereby declared to be the property of the State of Idaho. It shall be preserved, protected, perpetuated, and managed. It shall only be captured or taken at such times or places, under such conditions, or by such means, or in such manner, as will preserve, protect, and perpetuate such wildlife, and provide for the citizens of this state and, as by law permitted to others, continued supplies of such wildlife for hunting, fishing, and trapping*".

1.4.5.4.2 Idaho Department of Lands

The Idaho Department of Lands (IDL) is directed by Article IX-Section 8 of the Idaho Constitution to manage the approximately 2.4 million acres of state endowment lands "*in such a manner as to secure the maximum long-term financial return to the institution to which granted*." IDL has adopted a management policy that recognizes the value of wildlife and their habitats and considers the impacts to wildlife habitat in management plans or projects. Where appropriate, IDL takes measures that protect or improve important and critical wildlife habitat, subject to the fundamental mission of IDL to support the endowments.

1.4.5.4.3 Idaho Governor's Office of Species Conservation

Title 67, Section 818 of the Idaho Code allows Office of Species Conservation (OSC) to negotiate agreements with federal agencies concerning endangered, threatened, and candidate species. OSC is also responsible for coordinating the efforts of all state departments and divisions with duties and responsibilities affecting endangered species, threatened species, and species to be listed. In 2004, OSC's role was clarified to include petitioned and rare and declining species as well.

1.4.5.4.4 Idaho State Department of Agriculture

The mission of the Idaho State Department of Agriculture is "*serving consumers and agriculture by safeguarding the public, plants, animals, and the environment through education and regulation.*"

1.4.5.5 County government

County governments provide diverse services related to public safety, essential programs, natural resources, and manage public assets for the common well-being of each County's citizens. Counties have responsibilities related to planning and zoning, weed control, and permitting, among others. Some Idaho counties have also adopted local natural resource plans for purposes of creating a coordinating role with federal agencies, under FLPMA and the Forest Management acts. County government can play a valuable and important role in sage-grouse habitat conservation planning and implementation. Some counties have expressed an interest in entering into an MOU for sage-grouse habitat conservation. For those counties, a sample template for a County/IDFG MOU is located in Appendix K.

1.4.5.6 Non-governmental organizations and industry groups

1.4.5.6.1 Ada County Fish and Game League

The mission of the Ada County Fish and Game League is to assist in the conservation of wildlife resources in cooperation with similar associations and wildlife advocates for the benefit of all citizens, and to promote a high standard of sportsmanship and respect for Idaho's wildlife and associated natural resources on public lands.

1.4.5.6.2 Idaho Bird Hunters

The mission of Idaho Bird Hunters is to 1) enhance and perpetuate wild game birds in Idaho; 2) to establish and encourage conservation of game bird habitat; 3) to conduct research, training, and enhancement of knowledge concerning upland game birds; 4) to promote the shooting sport of game bird hunting through sportsmanship, educational programs on guns, and shot-gunning; and 5) field testing of gun dogs.

1.4.5.6.3 Idaho Conservation League

The Idaho Conservation League preserves Idaho's clean water, wilderness and quality of life through citizen action, public education, and professional advocacy.

1.4.5.6.4 Idaho Cattle Association

The mission of the Idaho Cattle Association is to coordinate and advance the economic well being of the Idaho Beef Industry through innovative and effective political, educational, and marketing programs accepted and supported by industry segments, partners, and coalitions.

1.4.5.6.5 Idaho Wildlife Federation

The mission of the Idaho Wildlife Federation is to promote the conservation and protection of our natural resources, wildlife, and wildlife habitat for current and future generations.

1.4.5.7 Landowners

Private landowners have specific rights in relationship to the lands they own. Their voluntary participation in actions that affect sage-grouse habitat is vital to the successful implementation of this Plan.

1.4.5.8 Members of the public

The participation of members of the public is important to the successful conservation of sage-grouse and sage-grouse habitat in Idaho.

1.5 Guidance, tools and resources

As noted previously, a primary purpose of this Plan is to support LWGs, non-governmental organizations, local governments, state and federal agencies, Tribes, private landowners, and members of the public, in their individual and collective efforts to effectively conserve Idaho sage-grouse populations and sagebrush communities. This Plan has been designed to provide those individuals and entities with guidance, information, conservation tools, and related resources necessary to achieve locally and regionally appropriate conservation objectives.

The following section includes some general and specific guidance, as well as a summary of some of the available tools and resources for use by new and existing LWGs, as well as in areas where no LWGs currently exist. Establishment of LWGs in SGPAs that currently lack them, and completion of LWG plans in all of Idaho's SGPAs, is a priority in Idaho. This Plan is intended to provide the basis for local planning so LWGs do not need to dwell on background or administrative detail in their plans. Thus, the LWGs may rely on the background information presented in this Plan and focus their efforts on local evaluations, on-the-ground projects, implementation and monitoring needs.

1.5.1 Summary of key activities

The following section summarizes the key activities that LWGs are expected to accomplish. In areas with an existing LWG some or all of these activities may have been completed or may be ongoing. Interim activities are also identified for areas with no LWG in place.

1.5.1.1 Areas with no Local Working Group

- In SGPAs with no LWG, the respective IDFG Region will lead organization of interagency start-up teams to begin aggressive outreach to establish a LWG. In 2004 and 2005 IDFG initiated start-up teams in several SGPAs that lack LWGs, including the Big Desert, East Idaho Uplands, and East, South, and West Magic Valley. These efforts will continue with initiation of LWGs in these areas anticipated by December 31, 2006. Formal IDFG regional support of a LWG in the Mountain Home SGPA is also anticipated by December 31, 2006. Table 1-2 identifies the primary agency offices in SGPAs that either lack LWGs or are in the process of starting up new LWGs.

Table 1-2 Summary of primary agency offices in sage-grouse planning areas currently without existing local working groups[8]

SGPA	Agency offices
Big Desert	BLM-Upper Snake, IDFG-Southeast, IDL, NRCS, ISDA, DOE
East Idaho Uplands	BLM-Pocatello, IDFG-SE & Upper Snake, IDL, Caribou NF, NRCS ISDA
East Magic Valley	BLM-Shoshone/Burley, IDFG-Magic Valley, IDL, National Park Service; Minidoka NWR, NRCS, ISDA
West Magic Valley	BLM-Shoshone, IDFG-Magic Valley, IDL, Sawtooth NF, NRCS, ISDA
South Magic Valley	BLM-Burley, Sawtooth NF, IDFG-Magic Valley, IDL, NRCS, ISDA, NPS
Mountain Home	BLM-Four Rivers, IDFG-SW & Magic Valley, Boise NF, NRCS, IDL, ISDA

- Interagency start-up teams, with the help of community members and others, will identify and recruit individuals who share an interest and stake in the conservation of sage-grouse and sagebrush communities to form and participate in a LWG. Interagency start-up teams should work aggressively to ensure a broad and balanced representation of interests on each LWG (e.g., private landowners, ranchers, farmers, citizens, non-governmental organizations, outdoor enthusiasts, conservationists, local government and industry, state and federal agency representatives, Tribal representatives, etc.).

- If start-up of a LWG is delayed the interim inter-agency team should identify threats or other conservation issues in order to initiate conservation actions (through projects, changes in management, etc.) deemed crucial to the conservation of sage-grouse and sage-grouse habitat in that SGPA. The interim

[8] Note: this list does not necessarily represent a comprehensive identification of agencies that would be involved, but is intended to represent primary agencies that may have specific management responsibilities in each SGPA.

inter-agency team should work together to ensure needed data are assembled and made available in support of annual updates to the Sage-grouse Habitat Planning Map (see Chapters 5 and 6), collaborate on annual updates to the SAC consistent with the guidelines for LWGs, and share other data as appropriate.

- Once a LWG is established in the individual SGPAs, it will be important for that LWG to review in the context of local conditions and information, any inter-agency products to identify (or refine) and prioritize, local threats and related conservation issues and measures. Interim identification of threats and conservation measures by inter-agency teams in areas without LWGs is in no way intended to preclude or supercede subsequent identification and prioritization of local threats in that SGPA once a LWG is in place and is operating.

- State and federal agency supervisors or line officers will support this interim process by assigning one or more local field staff (e.g., biologist, rangeland management specialist, fire use specialist, ecologist, or other, as appropriate) to participate on the start-up team (and subsequently on the LWG once it is established). Moreover, local agency managers should recognize there might be circumstances where their personal participation is also required. In addition, agency supervisors should also anticipate that there will be periodic need for timely GIS support at the local level.

1.5.1.2 Development of Local Working Group plan and timelines

- Each LWG should seek to assemble and maintain a diverse membership that includes a broad and balanced representation of interests (e.g., private landowners, ranchers, farmers, citizens, non-governmental organizations, outdoor enthusiasts, conservationists, local government and industry, state and federal agency representatives, Tribal representatives, etc.) The use of a trained facilitator is required from the initiation of LWGs through the development of a completed LWG plan. After the LWG plan is completed, a trained facilitator is strongly recommended, but optional, based on a decision of the LWG members. Funding for a trained facilitator will be provided.

- Develop and recommend quantifiable population objectives. Each LWG, with assistance from agency representatives, should develop and recommend specific population objectives based on lek counts, or best available data. LWG population objectives should contribute to the achievement of broad-scale population objectives presented in this Plan (see Section 1.3.1).

- Develop and recommend quantifiable habitat objectives. Each LWG, with assistance from agency representatives, should develop and recommend specific habitat objectives that maintain, and increase where possible, habitat quantity and quality based on local SGPA conditions and available monitoring data and research.

- Each LWG should identify, and to the extent possible, prioritize threats to sage-grouse populations and habitat at the local level. This state Plan provides a summary and prioritization of threats at a statewide scale. Several threats, including wildfire, infrastructure, annual grasslands, seeded perennial grasslands, and conifer encroachment have been substantially quantified at the SGPA level as well. This information is provided to facilitate the identification and prioritization of local threats at the SGPA or sub-SGPA level. LWGs that have not already completed this activity may wish to use the summary of statewide threats presented in this Plan as a starting point. Those who have already identified local threats may wish to review their identified threats in the context of the statewide threats.

- Existing LWGs with draft plans (i.e., Jarbidge, Shoshone Basin) should complete and finalize their plans no later than December 31, 2006.

- Existing LWGs that do not currently have draft plans (i.e., West Central, Challis) should complete and finalize their plans no later than December 31, 2007.

- New LWGs (i.e., formal LWG has not been initiated as of January 1, 2006) should make every effort to complete their respective plans within two years of inception of the LWG.

- Each LWG should identify appropriate conservation measures/actions to address localized threats to sage-grouse and sage-grouse habitat. This Plan includes a "toolbox" of recommended conservation measures for use and/or adaptation by LWGs in their own planning efforts.

- Each LWG should identify monitoring and evaluation actions necessary to update population and habitat data, and to gage the effectiveness of conservation actions. This effort should be closely coordinated with IDFG and other agencies. (See Chapter 5 for additional discussion.)

- New LWGs are expected to utilize the standardized outline for LWG plans presented in Section 1.5.2.2 of this Plan when developing their LWG plans.

- The SAC has not proposed a formal process for determining when a plan is complete. Currently, LWG plans are considered complete when approved by the

LWG (based on decision-making process and LWG membership as defined by each LWG).

1.5.1.3 Implementation of Local Working Group plans

- Each LWG should identify priority conservation actions and related projects based on their habitat and population objectives, local threat characterizations, and other known local factors (e.g., common sense, time-limited opportunities, etc.)

- Federal land management agencies that participate on the LWGs are expected to take the lead in facilitating, preparing, or contracting necessary (NEPA) documentation for specific recommended conservation actions on Federal lands. Although limitations in funding and human resources may in some instances constrain the level of Federal participation, active participation by Federal agencies is vital and should be considered a priority by the relevant agencies.

- Participating state agencies (IDFG, IDL, and ISDA), the NRCS, and in some cases county government, are expected to assume the lead for coordinating with private landowners, pursuing necessary authorizations or agreements and funding, and cooperating with the implementation of projects or conservation measures on private and state lands.

- Each LWG should provide information necessary to update the Sage-grouse Habitat Planning Map annually. The process for updating the map is described in detail in Chapter 5. Detailed reminders, including points of contact will be provided to LWGs each year in the early fall.

- Each LWG should provide a concise, written progress report to the SAC by December 31 of each year summarizing: (1) progress and success of project implementation within the SGPA; (2) status of studies, research, or research proposals within the SGPA; (3) discussion of new issues, project priorities, and problems; and (4) actions or projects planned for the ensuing year.

- Each LWG should update and/or revise their LWG plans at least every five years.

1.5.2 Local Working Group plan outline

A number of the LWGs in Idaho have been working collaboratively on development of their plans for quite some time. The dedicated efforts of the private citizens, non-

governmental organization and agency representatives, and facilitators, who have participated in these processes, have contributed substantially to the development of this state Plan.

Participants in these processes have indicated that providing consistent guidelines regarding the desired structure and overall content of the LWG plans as well as other tools that might facilitate the LWG plan development (e.g., a summary types of threats, biological background information, etc.), could substantially accelerate the development of new LWG plans, and contribute value to plans that are currently in development.

The following outline is based on lessons learned from the development of the initial LWG plans, ongoing planning efforts, ideas gleaned from other states' sage-grouse plans, and from Idaho's own statewide planning efforts. This outline is designed to promote consistency among Idaho's LWG plans and aid in the timely completion of those plans.

1.5.2.1 How the outline is intended to be used

This LWG plan outline is provided with the following specific *recommendations and/or requirements*:

- New LWGs (i.e., formal LWG not initiated as of January 1, 2006) will be *required* to use this outline as the basis for their LWG plans;

- Existing LWGs (i.e., formed prior to January 1, 2006) that are developing, but have not completed, their LWG plans as of December 31, 2006, are *strongly encouraged* to use this outline as the basis for their plans;

- LWGs that have completed or will complete their plans prior to December 31, 2006 are not required to use this outline but *may wish to consider* adopting this format when completing revisions or updates to their plans in the future.

1.5.2.2 Outline components

LWGs may wish to add additional chapters (other than those identified here) to their plans but the following outline identifies minimum content and recommended organization:

A. Introduction
   - Conservation goals and objectives for the SGPA
   - Summary of LWG participation and planning process

B. Status of sage-grouse habitat and population in the SGPA
   - Population overview (see Chapter 3)
   - Habitat conditions overview (see Chapter 3)
     Note: the repetition of background information related to sagebrush and sage-grouse ecology is readily available in the state Plan and Rangewide Conservation Assessment. Unless there are compelling reasons, or unique local situations, the reiteration of this information is not needed or recommended.

C. Threats to sage-grouse and sage-grouse habitat in the SGPA
   - Identify local threats to sage-grouse and sage-grouse habitat
   - Use the discussion and prioritization of statewide threats presented in this state Plan as a starting point to identify and prioritize local threats (see Chapter 4).
   - Consider using the ranking process employed by the Idaho Sage-grouse Science Panel (Appendix E).

D. Conservation measures to address local threats
   - Identify specific conservation measures (actions) appropriate to address locally identified threats, including potential restoration projects or other treatments (see Section 4.3)

E. Monitoring and evaluation
   - Identify monitoring actions necessary to ascertain effectiveness of conservation measures and progress towards meeting conservation goals and objectives (see Chapter 5).
   - The Idaho sage-grouse habitat restoration coordinator is available to assist with monitoring-related questions/protocols (see Appendix F for contact information).

F. Implementation strategy
   - Present an implementation strategy for the LWG plan that includes identification of: who, what, when, how and where.

G. Adaptive management
   - Identify a process and/or timeline for updating and/or revising the various components of the LWG plan.

H. Literature citations

I. Appendices (as necessary)

1.5.3 Additional support and tools for Local Working Groups

The following support and tools will be provided to LWGs. The purpose of these activities and tools is to facilitate effectiveness of LWG processes and products, and to improve communication, coordination and consistency between LWGs.

- *Regular communication with and between LWG members.* Regular meetings of the Sage-grouse Advisory Committee (SAC), and other methods (e.g., regular email updates, etc.) will be used to ensure that LWG members receive regular and timely informational updates and have adequate opportunities to coordinate activities or talk with other LWGs as deemed beneficial to their objectives.

- *Provide for a neutral, trained facilitator.* To ensure LWG meetings are planned and executed around a specific agenda; foster balanced, constructive participation by all group members; assist the group in articulating key points; and ensure notes or minutes are recorded and disseminated in a timely manner, provisions will be made for a neutral, trained facilitator for each start-up LWG through to completion of a LWG plan. Those LWGs with completed plans are strongly encouraged to continue using a trained facilitator and funding will be provided for that purpose. Implementing agencies will identify funding needs and potential funding sources for additional facilitators.

- *Provide support to resolve internal LWG disagreements.* In cases where LWGs are unable to arrive at agreement or consensus with respect to local objectives, conservation measures, interpretation of data, or other issues, the LWG may request review of the issue by the statewide Sage-grouse Advisory Committee (SAC).

- *Make available expertise of the sage-grouse habitat restoration coordinator and other technical experts.* In 2005, IDFG hired an individual to assist LWGs with planning, grant/proposal writing, implementation and monitoring of restoration projects (see Appendix F for contact information.)

- *Facilitate NEPA and out-year project planning.* Participating federal agencies are expected to help LWGs by taking the lead in facilitating, preparing, or contracting necessary National Environmental Policy Act (NEPA) documentation, as needed, for specific recommended conservation actions on

public lands. Project proposals or measures should also be incorporated into respective agency activity plans, annual work plans, or out-year funding proposals as appropriate.

1.6 Implementation funding

Adequate funding is essential to the success of this conservation effort. The SAC will quantify financial and staffing needs to implement this plan at both the local and statewide levels and identify strategies to obtain funding by December 31, 2006. The SAC will also coordinate with Western Association of Fish and Wildlife Agencies, the Western Governors Association, federal agencies, and others to obtain funding needed for sage-grouse conservation. Identification of adequate funding is a priority for the SAC. In addition, LWG members should work to identify alternative local and partnership funding.

1.7 Use of WAFWA guidelines in Plan

The Western Association of Fish and Wildlife Agencies (WAFWA) tasked a team of biologists to update sage-grouse habitat management guidelines developed in the mid 1970s (Braun et al. 1977). The resulting Connelly et al. guidelines (referred to in this document as the WAFWA guidelines, or Connelly et al. 2000*b*) were designed to pre-empt, reverse, or mitigate population declines and maintain viable populations of sage grouse based on best available current data and knowledge (Connelly et al. 2000*b*).

The WAFWA guidelines were based on a compilation of literature, and describe general site conditions necessary to meet the seasonal habitat requirements of sage-grouse (Connelly et al. 2000*b*). In presenting the WAFWA guidelines, the authors acknowledged information gaps and regional variations in habitat structure, composition, and other factors, and therefore recommended that local biologists apply quantitative data from habitat and population monitoring in responding specifically to local conditions.

Moreover, the WAFWA guidelines do not describe desired conditions for habitat on a landscape scale, nor do they identify plant composition and structural characteristics across all sagebrush communities in which sage-grouse occur. Some of the federal agencies are currently working to develop a strategy to evaluate habitat at the landscape scale, meet the habitat needs of sage-grouse and other animals that are associated with the sagebrush steppe ecosystem, and prescribe appropriate management strategies that address multiple scales.

In the context of this Plan the WAFWA guidelines were used as a technical reference to help guide development of a toolbox of conservation measures that LWGs and others may select from and/or adapt as appropriate to local conditions, in order to maintain and/or enhance sage-grouse populations and habitat in Idaho. The authors of this Plan recognize there may be important local variations in habitat structure and composition, as well as other local factors, which will also influence the selection, design, and implementation of appropriate site-specific conservation actions.

1.8 WAFWA Range-wide conservation strategy

The WAFWA Conservation Planning Framework Team has initiated development of the Range-wide Sage-grouse and Sagebrush Conservation Strategy (R-W Strategy). Completion is scheduled for December 2006. State-level (e.g., Idaho Sage-grouse Conservation Plan) and Local Working Group conservation plans will form the foundation of the R-W Strategy. Substrategies developed by various teams will address the following elements: (1) funding, (2) communication and outreach, (3) implementation monitoring, (4) conservation issues, (5) effectiveness monitoring, (6) adaptive management, and (7) research/technology. The national BLM Sage-grouse Habitat Conservation Strategy will also be incorporated in conjunction with Range-wide Strategies Team processes.

A national interagency group, the Sage-grouse Habitat Assessment Framework Technical Working Group, has also been formed to assist in developing a standardized approach for describing sage-grouse habitats. This tool will enhance cooperative conservation efforts across state and jurisdictional boundaries, by providing consistent processes, terminology and related information.

Chapter 2 – Sage-grouse and Sagebrush Ecology

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2 Sage-grouse and Sagebrush Ecology

An overall understanding of sage-grouse ecology and sagebrush ecology is important to those who wish to participate in sage-grouse conservation planning and design and implementation of effective conservation actions. The following chapter briefly summarizes key highlights of sage-grouse ecology in Section 2.1, and provides an overview of sagebrush ecology in Section 2.2. Both sections provide references to additional information that Local Working Group members, agency staff, and other individuals and organizations using this Plan may find valuable. Additional details regarding sage-grouse seasonal habitat characteristics can be found in Chapter 5, Section 5.3.2 and Appendix D.

2.1 Sage-grouse ecology

A considerable wealth of information related to greater sage-grouse population biology and habitat use has been published over the past several decades. Idaho biologists have long played an important leadership role in research efforts to improve our understanding of this species. While questions continue to challenge biologists and wildlife managers, sage-grouse, nonetheless, are one of the most scrutinized and well-understood species of the sagebrush ecosystem. Space in this document does not permit an exhaustive review of the literature; however, Schroeder et al. (1999), Connelly et al. (2000*b*), Wambolt et al. (2002), Connelly et al. (2004), and Schroeder et al. (2004) offer up-to-date, detailed information on the ecology of greater sage-grouse. Additionally, Benedict et al. (2003) provides information on the genetics of greater sage-grouse. Crawford et al. (2004) provides a synthesis paper on the ecology and management of sage-grouse and sage-grouse habitat.

2.1.1 Taxonomy and behavior overview

Two species of sage-grouse occur in western North America. The greater sage-grouse is the focal species in this Plan. This grouse is a large upland game bird that was once widespread throughout sagebrush-dominated habitats of the western United States and Canada, and abundant in some areas. Adult males weigh 1.8-3.6 kg (4-8 pounds) and adult females 0.9-1.8 kg (2-4 pounds). This species currently occurs in ten western states and two provinces (Schroeder et al. 2004). Although the greater sage-grouse was divided into western and eastern subspecies (Aldrich 1946), recent genetic analysis has not supported this delineation (Benedict et al. 2003). The

Gunnison sage-grouse (*Centrocercus minimus*) inhabits portions of Colorado and southeastern Utah and is a smaller relative of the greater sage-grouse. The Gunnison species is currently classified by the USFWS as a candidate for threatened status and is being managed under separate conservation planning efforts.

During the spring (normally early March to mid-May), males gather on traditional breeding areas, called leks, for displaying and mating. Using elaborate plumage displays and inflatable air sacs that produce a loud "plopping" sound males attract females and protect their territory on the lek from other males. Females normally begin moving from winter to breeding areas from late February to early March, but actual lek attendance varies somewhat throughout the species range (Connelly et al. 2004). After breeding, females move away from the lek to establish nests. Evidence suggests that nest sites are selected independent of lek location (Wakkinen et al. 1992). In Idaho, hens nest an average of 3-5 km (2-3 mi) from their lek of capture but may move more than 18 km (11 mi) to nest (Connelly et al. 2004).

2.1.2 Migration

Three types of seasonal movement patterns have been described for greater sage-grouse: (1) non-migratory; grouse do not make long distance movements (e.g., >10 km (6 mi) one way), (2) one-stage migratory; grouse move between two distinct seasonal ranges, and (3) two-stage migratory; grouse move among three distinct seasonal ranges (Connelly et al. 2000*b*). Many sage-grouse populations in Idaho are migratory. Some birds range up to 125 km (77.5 mi) with a home range of 2,764 km^2 (1,067 mi^2) (Leonard et al. 2000). Most migratory movements tend to be slow and meandering (Dunn and Braun 1986*a*, Connelly et al. 1988), but relatively long-distance movements can occur over just a few days (Schroeder et al. 1999). In the late summer and early fall, migratory sage-grouse often congregate into flocks in preparation for movement to traditional wintering grounds. Despite large annual movements, greater sage-grouse show high fidelity to seasonal ranges (Schroeder at al. 1999). Female sage-grouse return to the same area to nest each year (Fischer et al. 1993) and some may nest within 200 m (656 ft) of their previous year's nest (Lyon 2000).

2.1.3 Population biology

Sage-grouse are long-lived for an upland game bird. Four- and five-year-old birds are not unusual and 60-80% of adult females commonly survive each year. Survival rates of adult males usually range from 50 to 60% (Connelly et al. 2004). Sex ratios for adult sage-grouse are skewed in favor of females (Connelly et al. 2004), and the

lower survival rate of males compared to females is the likely cause of this sex ratio. In contrast, most other upland game birds are characterized by populations with the majority of individuals under one year-of-age, and exhibit adult survival rates of about 30% each year.

Within 7 to 10 days after breeding the hen builds a nest. The peak of egg-laying and incubation varies from late March through mid-June depending on weather, elevation, and plant phenology (Schroeder et al. 1999). Nest bowls may be scratched or dug immediately before the first egg is laid although relatively few specifics are known. In Idaho, clutch sizes for greater sage-grouse average 6 to 7 eggs, relatively low for an upland game bird (Connelly et al. 1993, Apa 1998, Wik 2002). Incubation starts when the last egg is laid or one to two days after. The incubation period is 25 to 29 days (Schroeder et al. 1999). Adult female (≥2 years old) sage-grouse nest about 80% of the time, while yearling females nest about 55% of the time. In Idaho, about 15% of sage-grouse hens that lose a nest will subsequently re-nest (Connelly et al. 1993, Wik 2002). In contrast, nearly all sharp-tailed grouse (*Tympanuchus phasianellus*) and ring-necked pheasant (*Phasianus colchicus*) nest each year and may attempt to re-nest up to four times if previous nests are destroyed. The greater sage-grouse has one of the lowest reproductive rates of any North American game bird, and its populations are not able to recover from low numbers as quickly as many other upland game bird species.

Drought may affect sage-grouse populations by reducing herbaceous cover at nests, and food quality/quantity for hens and chicks (Hanf et al. 1994, Fischer et al. 1996*a*). Relatively wet springs may result in increased production (Wallestad 1975, Autenrieth 1981). However heavy rainfall during egg-laying or unseasonably cold temperatures with precipitation during hatching may decrease production (Wallestad 1975).

2.1.4 Habitat characteristics

Greater sage-grouse are dependent on large areas of sagebrush/grassland habitats with 15-25% sagebrush canopy cover for breeding habitat and 10-30% canopy cover for winter habitat. A healthy perennial grass and forb understory is also an important component of nesting and brood-rearing habitat. The availability of a diversity of forbs rich in calcium, phosphorus and protein are also important to pre-laying hens (Connelly et al. 2000b). On an annual basis migratory sage-grouse populations may occupy an area that exceeds 2,700 km^2 (1,042 square miles) (Hulet 1983, Leonard et al. 2000). During winter, Robertson (1991) reported that migratory sage-grouse in southeastern Idaho made mean daily movements of 752 meters (2,467 ft) and occupied an area greater than 140 km^2 (54 square miles). For a non-migratory population in Montana, Wallestad (1975) reported that winter home range size ranged

from 11 to 31 km^2 (4.2 to 12 square miles). During summer, migratory sage-grouse in Idaho occupied home ranges of 3 to 7 km^2 (1.2 to 2.7 square miles) (Connelly and Markham 1983, Gates 1983).

Most sage-grouse select nest sites under sagebrush (Patterson 1952, Connelly et al. 1991). In general, sagebrush and perennial understory grasses and forb cover are key components of sage-grouse nesting and early brood-rearing habitat. If sagebrush is eliminated from a large area, it will not support sage-grouse populations because nesting success and/or juvenile survival will be reduced. Recent research has shown that perennial herbaceous cover is particularly important for sage-grouse reproduction (Barnett and Crawford 1994, Gregg et al. 1994). Benefits provided by herbaceous understory include increased access to insects and forbs by hens before breeding and by chicks. Herbaceous understory also provides cover to hide nests, eggs and chicks from predators.

Insects are a key component of sage-grouse early brood-rearing habitat. A high protein diet of insects is necessary for all young upland game birds during the first month of life. Sage-grouse chick survival is lower if insects are unavailable (Johnson and Boyce 1990), probably because of starvation and increased vulnerability to predation while searching for scarce food. The most productive sage-grouse brood-rearing habitat includes a perennial grass and forb canopy cover of ≥15%, as well as a 10-25% canopy cover of sagebrush (Connelly et al. 2000b). Late summer (mid-July to September) brood-rearing habitat may include agricultural fields, meadows, and riparian areas adjacent to big sagebrush communities. In years of above average summer precipitation, late summer brood-rearing habitat may overlap early summer brood-rearing habitat.

During winter, sage-grouse feed almost exclusively on sagebrush leaves (Patterson 1952, Wallestad et al. 1975). If adequate sagebrush is available for winter food and cover, sage-grouse are seldom impacted by severe winter weather, and sage-grouse gain weight during winter (Beck and Braun 1978). However, loss of sagebrush on winter ranges may severely impact sage-grouse populations (Beck 1977).

In general, sage-grouse populations decline when large areas of sagebrush/grassland habitat are altered or fragmented. Reducing or eliminating sagebrush canopy cover, seeding-introduced grass species, conversion to agriculture, fire, suburban development, invasion by annual grasses, and management that results in a significant reduction of the perennial grass/forb understory have all been responsible for sage-grouse habitat loss or degradation. Additionally, power lines, roads and highways, reservoirs, and other developments commonly cause fragmentation of sagebrush ecosystems (Connelly et al. 2004).

Connelly et al. (2000*b*) summarized habitat characteristics that were representative of productive sage-grouse habitat (Appendix D). The authors noted that vegetative characteristics generally associated with productive habitats might not occur in some areas. In these cases, the authors suggested that local biologists and range ecologists develop height and cover requirements that are reasonable and ecologically defensible. Additionally, Connelly et al. (2000*b*) indicated that because of gaps in our knowledge and regional variation in habitats, the judgment of local biologists/ecologists and quantitative data from population and habitat monitoring are necessary to implement management guidelines correctly. They urged agencies to use an adaptive management approach (MacNab 1983, Gratson et al. 1993) using monitoring and evaluation to assess the success of implementing the guidelines to manage sage-grouse populations. They also recommended that local and regional conservation plans should summarize conditions needed to maintain healthy sage-grouse populations and stated that local differences in conditions should be considered in these plans.

2.2 Sagebrush ecology

Sagebrush species and subspecies are distributed along complex and interacting gradients of elevation, precipitation, temperature, aspect, slope, and soil depth, texture, and salinity. The woody sagebrushes provide critical habitat components and are a major food source for sage-grouse (Braun et al. 1977, Drut et al. 1994b, Connelly et al. 2000*b*). Sage-grouse are dependant on the full diversity of sagebrush systems for their annual food and cover. This relationship is reflected by the close alignment of their distribution with the range of sagebrush, particularly big sagebrush (*Artemisia. tridentata*) and silver sagebrush (*A. cana*) communities. This relationship is perhaps tightest in the late autumn, winter, and early spring when sage-grouse are dependent on sagebrush plants themselves for both food and cover. In much of the west historically heavy livestock use has reduced forb, perennial grass, and biological soil crust components, allowing sagebrush and exotic annuals to become dense (Billings 1994, Rosentreter and Eldridge 2002).

Woody sagebrush species have been of major interest and concern to land managers for many years. An understanding of the types of sagebrush that sage-grouse utilize for food and cover, and where these sagebrush types occur on the landscape is essential in conservation planning for the species. Species and subspecies of sagebrush have moderate to vastly different palatability and structural characteristics which influence their particular values for wildlife (Sheehy and Winward 1981). Winward and Tisdale (1977) state that the separation of big sagebrush into subspecies assists in the recognition of habitat types, production potential, chemical content, and palatability preference.

The ability to recognize the various sagebrush communities is important because they are indicators of a given local ecosystem composed of specific vegetation types, soil depth, climate, topography, and wildlife species. Fortunately, sagebrush communities are generally repetitive and easily identifiable (Beetle 1960, West 1988). Winward (2004) provides a concise reference for many sagebrush species and subspecies, with excellent color photographs. However, initial and periodic refresher training, including field-trips, on the identification and ecology of the various sagebrush species and subspecies is strongly recommended for members of LWGs, including agency specialists. Differences in some sagebrush species and subspecies can be subtle to the untrained eye. To that end, sagebrush identification and ecology field trips can be arranged throughout Idaho. Interested LWGs or agency specialists should forward requests for such training to the Idaho Sage-grouse Advisory Committee coordinator.

While selected aspects of sagebrush identification and ecology are presented below, an exhaustive treatment of the subject is beyond the scope of this chapter. For additional detail, see the following references: Anderson and Holte (1981), Anderson and Inouye (2001), Hironaka et al. (1983), McArthur and Welch (1986), Miller et al. (1994), Miller and Eddleman (2001), Passey et al. (1982), Tisdale et al. (1969), Tisdale and Hironaka (1981), Schlatterer (1972), Welch (2005), Welch and Criddle (2003),West and Young (2000). Complete citations are located in the Literature Cited section of this Plan. Additional detailed information on sagebrush (and other plant species), and fire ecology/ management is readily available at the following websites:

- Fire Effects Information System: http://www.fs.fed.us/database/feis/
- Landfire website: http://www.landfire.gov/modelswestern.html

2.2.1 Palatability of sagebrush

An understanding of the relative palatability of sagebrush species and subspecies is potentially useful in delineating seasonal habitats or to aid in the selection of sagebrush species/subspecies for restoration purposes. However, the overall *availability* of sagebrush to meet the various seasonal cover and foraging needs of sage-grouse at local and broader scales is probably of greater importance in conservation planning. For example, in lower elevation sage-grouse wintering or nesting areas, the presence and availability of Wyoming big sagebrush on the appropriate ecological site is desirable from a conservation perspective, even though

other sagebrush subspecies may be more palatable. With that in mind, the following two paragraphs, paraphrased from Rosentreter (2005), provide a concise overview of factors affecting the palatability of sagebrush.

It is well documented that some sagebrush species are more palatable to wildlife due to their specific chemical content (Morris et al. 1976, Sheehy and Winward 1981, Welch et al. 1983, Wambolt 2001). The difference in palatability is based on plant chemistry and the amount of volatile chemicals present in sagebrush leaf glands (Kelsey et al. 1984, Striby et al. 1987). Leaf glands vary seasonally in the amount and concentration of chemicals they contain, with concentrations highest in spring and lowest in winter (Cedarleaf et al. 1983, Kelsey et al. 1984). This is due to the semi-evergreen nature of sagebrush and the presence of persistent leaves produced in the spring, the glands of which are full of volatile chemicals that discourage herbivory. With release of volatile chemicals, the sagebrush leaf becomes more digestible. This process has been demonstrated through in vitro (laboratory) digestibility studies of sagebrush leaves and alfalfa with the addition of sagebrush-specific volatile compounds (Striby et al. 1987, Wambolt et al. 1991). Thus, while some sagebrush species' high crude protein content encourages herbivory, others contain chemicals such as volatiles, methacrolein, acetone, and 1-8 cineole that discourage feeding (Kelsey et al. 1982, Wambolt et al. 1991, Wambolt 1996).

Most sagebrush palatability information is not specific to sage-grouse, but instead is based on observations of other wildlife species and digestibility experiments by Kelsey, Wambolt, and others (Schwartz et al. 1980, Sheehy and Winward 1981, Kelsey et al. 1982, Yabann et al. 1987, Wambolt et al. 1991, Barnett and Crawford 1994, Wambolt 2001). The palatability of sagebrush and other plants varies depending on the adaptations of the individual animal or population of animals feeding on it. In addition to the chemical content of food, learned behaviors may also dictate the food choices animals make.

2.2.2 Types of sagebrush

Three major structural types of sagebrush plants in Idaho are (1) tall sagebrush, (2) dwarf sagebrush, and (3) sub-shrub sagebrush (Rosentreter 2005). These broad sagebrush types are used by sage-grouse for food, escape cover, and/or nesting habitat. Tall sagebrush types provide the best escape cover and nesting habitat for sage-grouse. Dwarf sagebrushes may be more palatable (Rosentreter 2005) and are critical food sources in the winter for sage-grouse but do not provide good escape cover or nesting habitat due to their lower stature. Subshrub sagebrushes are also low in stature and are of only moderate to low palatability (Rosentreter 2005).

2.2.2.1 Tall sagebrush types

Tall sagebrush types most common in Idaho are Wyoming big sagebrush, mountain big sagebrush, basin big sagebrush, and xeric big sagebrush. Additional species include threetip sagebrush and silver sagebrush.

Wyoming Big Sagebrush (*Artemisia tridentata ssp. wyomingensis*)**:** Wyoming big sagebrush is a medium-sized shrub from 1-3 ft tall; it branches from the base, and has an uneven crown (Rosentreter 2005). This subspecies occurs in foothills, undulating terraces, slopes, and plateaus, as well as basins and valley bottoms. Precipitation averages 7-12 inches (McArthur 2000). In Idaho, Wyoming big sagebrush occurs between 2,500 and 6,500 ft in elevation (Johnson 1999). Wyoming big sagebrush sites have fewer understory species compared to other big sagebrush subspecies (Howard 1999).

Many researchers believe fire historically played an important role as a disturbance factor in Wyoming big sagebrush (http://www.landfire.gov), though Miller and Eddleman (2001) suggest burn patterns in this type were patchy due to limited and discontinuous fuels. Other disturbance factors include insects such as the *Aroga* moth (see Welch 2005 for additional information), drought/wet cycles, rodents and lagomorphs, climate change, and grazing (http://www.landfire.gov). Fire return intervals reported in the literature vary (e.g., 25-100+ years, West 2000; 50-100 years Wright and Bailey 1982). Current scientific opinion is about 100 years (http://www.landfire.gov). However, Baker (2006) suggests fire rotations in Wyoming big sagebrush may be considerably longer, at 100-240 years. Fire return intervals have been shortened to 2-4 years in some areas of the Snake River Plain, due to cheatgrass (Whisenant 1990). Recovery of Wyoming big sagebrush post-fire can be slow, relative to other big sagebrush subspecies due to the relatively drier sites it occupies (Johnson 1999).

Wyoming big sagebrush is generally palatable, though its palatability is highly variable (Rosentreter 2005). Sage-grouse use Wyoming big sagebrush sites for wintering, pre-laying, nesting and brood-rearing habitat (Crawford et al. 2004).

Many Wyoming big sagebrush sites have been severely degraded, and converted to exotic annual grasslands (Hilty et al. 2003). Non-degraded, lightly grazed Wyoming big sagebrush sites have a high percentage of biological soil crusts and low percentage of cheatgrass (*Bromus tectorum*) cover (Rosentreter 1986, Kaltenecker et al. 1999, Rosentreter and Eldridge 2002). Due to their susceptibility to invasion and domination by cheatgrass and other exotic annuals, and slow recovery, use of fire to manage these sites must be approached with caution. Wyoming big sagebrush sites should be managed for the restoration or retention of the biological soil crust

component where possible, most critically in the lower precipitation zones (Rosentreter 2005). Late fall, winter, and early spring are the most appropriate seasons of use for livestock in this low-elevation vegetation type (Rosentreter 2005). Four to six weeks of moist soil conditions in late spring facilitates growth of biological soil crusts disturbed by trampling (Memmott et al. 1998, Rosentreter and Eldridge 2002).

Mountain Big Sagebrush (*Artemisia tridentata ssp. vaseyana*): Mountain big sagebrush generally grows above 5,000 ft (Rosentreter 2005). Mean annual precipitation is 14-22 inches, but can range from 10-30 inches (Mueggler and Stewart 1980, Tart 1996). It typically occurs on moist, productive, rolling upland sites. Soils are typically deep and have well developed dark organic surface horizons (Hironaka et al. 1983, Tart 1996). This sagebrush subspecies branches from the base, grows to 3 ft tall, and typically has an even, flat-topped crown (Tisdale and Hironaka 1981, Rosentreter 2005).

Mean fire return intervals have been debated (Welch and Criddle 2003). Mountain big sagebrush communities were historically subject to stand replacing fires with a mean return interval ranging from 10 years at the Ponderosa pine ecotone, to 40+ years at the Wyoming big sagebrush ecotone, and up to 80 years in areas with a higher proportion of low sagebrush in the landscape (Crawford et al. 2004, Johnson 2000, Miller et al. 1994, Burkhardt and Tisdale 1969, Burkhardt and Tisdale 1976, Houston 1973, Miller and Rose 1995, Miller et al. 2000). However Baker (2006) suggests fire rotations were longer, ranging from 70-200 years.

Recovery rates for mountain big sagebrush vary, typically reaching 5% canopy cover in 8-14 years; and can reach 25% canopy in 25 years (range 9-70 years) (Winward 1991, Pedersen et al. 2003).

Mountain big sagebrush is highly palatable to wildlife; however, limited access in the winter and the chemical content in spring and summer may discourage herbivory (Kelsey and Shafizadeh 1978, Kelsey et al. 1984). Mountain big sagebrush sites generally provide winter, nesting and brood-rearing habitat for sage-grouse (Crawford et al. 2004). Mountain big sagebrush can be a major food source for sage-grouse in the winter months (Rosentreter 2005).

Mountain big sagebrush has a greater potential to increase its density, as compared to other sagebrush taxa, due to the higher moisture associated with its sites and its general ecology (Rosentreter 2005). Stands can become so dense that they may exceed sagebrush cover conditions needed for productive sage-grouse nesting or brood habitat described in the WAFWA Guidelines. At the ecotone with conifer forests or pinyon-juniper communities, mountain big sagebrush sites are readily invaded by these species in the absence of fire or other disturbance (Miller and Rose

1999). Mechanical control, burning, or other treatments may be necessary in some areas to restore desirable plant composition and structure to meet wildlife habitat objectives.

Basin Big Sagebrush (*Artemisia tridentata ssp. tridentata*): Basin big sagebrush is found between about 3,000-6,000 feet; annual precipitation ranges from 8 to 14 inches (see http://www.landfire.gov). It commonly grows on deep, fertile, well-drained soils in valley bottoms, lower foothill areas or in areas adjacent to drainages (Tirmenstein 1999). Because it tends to grow on productive sites, many areas once dominated by this subspecies are now farmland (Young and Evans 1981, Pechanec et al. 1954 cited in Tirmenstein 1999).

Basin big sagebrush tends to be single-trunked, or tree-like or Y-shaped in appearance and the crown is uneven (Rosentreter 2005). It normally reaches 3-10 feet in height. Areas dominated by Wyoming big sagebrush frequently have basin big sagebrush occurring along road ditches due to the extra moisture runoff from roads. Consequently, basin big sagebrush seed is often inadvertently harvested along with the seed of Wyoming big sagebrush (Rosentreter 2005).

In comparison with mountain and Wyoming big sagebrush, basin big sagebrush is least preferred by sage-grouse (Welch 1991 cited in Tirmenstein 1999). Relative palatability of basin big sagebrush appears to be among the lowest of 23 species or subspecies of sagebrush evaluated (Rosentreter 2005). Basin big sagebrush leaves have rarely been identified in sage-grouse scats (Rosentreter 2001, unpublished data; Vasquez 2002). Because of the treelike growth form, it is likely that mature stands of basin big sagebrush may provide only marginal cover value to nesting sage-grouse. Younger stands with lower growing plants may provide suitable cover for nesting and broods, but information in the literature is lacking. The currently limited extent of basin big sagebrush on the Idaho landscape also suggests that this subspecies is of less significance overall than other big sagebrush subspecies, such as Wyoming and mountain big sagebrush.

Fire-return intervals for basin big sagebrush types are estimated to average approximately 60 years, ranging from 10-150 years (see http://www.landfire.gov), and are intermediate between those of mountain and Wyoming big sagebrush (Sapsis 1990 cited in Tirmenstein 1999).

Xeric or Foothill Big Sagebrush (*Artemisia tridentata ssp. xericensis*): Xeric big sagebrush is a tall shrub (>3 ft) with Y-shaped architecture similar to that of basin big sagebrush (Rosentreter 2005). Its chemistry, leaf shape, and palatability are most similar to mountain big sagebrush (Rosentreter 2005). This Idaho subspecies is restricted to heavy clay-loam and drier, xeric soils, than mountain big sagebrush, and occurs from approximately 2,500-5,400 ft (Roesntreter and Kelsey 1991, Rosentreter

2005). Average annual precipitation ranges from 12-22 inches (Rosentreter and Kelsey 1991). It appears to have been initially derived through hybridization between basin big sagebrush and mountain big sagebrush (Rosentreter and Kelsey 1991). Its distribution is limited to west-central Idaho, predominantly Washington County, and portions of adjoining counties (Rosentreter and Kelsey 1991). Xeric big sagebrush is heavily utilized in winter by mule deer and, based on its chemistry (high crude protein) (Rosentreter and Kelsey 1991), is likely preferred by sage-grouse (Rosentreter 2005). Information on fire history is currently unavailable.

Tall Threetip Sagebrush (*Artemisia tripartita ssp. tripartita*)**:** Tall threetip sagebrush is a fairly tall, erect shrub. It ranges from 16-32 inches tall (Winward 2004) though can reach up to 4-6 ft (Rosentreter 2005). A second subspecies, Wyoming threetip sagebrush (*Artemisia tridentata* ssp. *rupicola*), apparently does not occur in Idaho, though occurs in Wyoming, Montana, and southern Oregon (Tirmenstein 1999, Winward 2004). In the Intermountain Region, tall threetip is found between approximately 3,400 to 7,100 ft elevation (Tirmenstein 1999). Tall threetip sagebrush grows on deep, well-drained soils, often mixed with basin or mountain big sagebrush, and can also dominate playa situations (Rosentreter 2005). Tall threetip will seldom layer[1] without disturbance but will vigorously stump-sprout and layer after burning (Rosentreter 2005). Because of this, it can increase in density and acreage when disturbed (Winward 2004), and can form nearly pure stands postfire (Tirmenstein 1999). In Idaho, tall threetip is common in parts of the Upper Snake River Plain. Information on fire return intervals is not readily available.

In southern Idaho, sage-grouse may include small amounts of threetip sagebrush leaves in their diets but it is not preferred browse for most wild ungulates (Tirmenstein 1999). It provides food, cover, and nesting habitat for sage-grouse (Gray 1967, Klebenow 1969, Hironaka et al. 1983, Sveum et al. 1998a).

Silver Sagebrush (*Artemisia cana*): Two subspecies of silver sagebrush occur in Idaho; mountain (*A. cana ssp. viscidula*) and Bolander (*A. cana ssp. bolanderi*) (Hironaka et al. 1983, Rosentreter 2005), and they are found in distinctly different habitats.

Mountain silver sagebrush ranges from 0.3 to 1 ft in height and occurs from 6,000-8,000 ft in Idaho (Schlatterer 1972). It occurs in mountain meadows, stream terraces and stringers along stream courses, terraces, or areas of heavy winter snowpack (Schlatterer 1972, Hironaka et al. 1983, Howard 2002, Rosentreter 2005,). Mountain silver sagebrush sites are very productive, with a diversity of forbs, grasses and other shrubs (Howard 2002, Winward 2004). Where these sites occur within the elevational range of sage-grouse, they provide forage and cover for sage-grouse

[1] To form roots where a stem or branch comes in contact with the ground.

adults and chicks (Winward 2004). Rosentreter (2005) ranked mountain silver sagebrush as highly palatable to sage-grouse. Mountain silver sagebrush is locally dominant on mountain grassland clay soils of central and eastern Idaho, where it forms the Camas Prairie association with common camas (*Camassia quamash*) (Rosentreter 1992 cited in Howard 2002).

Silver sagebrush resprouts strongly after being top-killed by fire (Britton1979, Cronquist et al. 1994, Wright and Bailey 1982, and Wright et al. 1979). Mean fire return intervals in mountain silver sagebrush range from 3 to 45+ years (Arno 1980, Arno 2000, Heyerdahl et al. 1994). Houston (1973) estimated that on the Snake River Plain of Idaho, fires probably cycled about every 25 years in the wetter areas favored by mountain silver sagebrush.

Bolander silver sagebrush is generally less than 3 ft in height (Howard 2002) and most commonly occurs within internally drained basins (playas) (Hironaka et al. 1983, Rosentreter 2005). Rosentreter (2005) ranked it as moderately palatable to sage-grouse. Fire history studies in Bolander silver sagebrush communities are apparently lacking (Howard 2002).

2.2.2.2 Dwarf sagebrush types

Dwarf sagebrush types most common in Idaho include early, black, and low sagebrush, and budsage. Chicken sage, while not an *Artemisia*, is also discussed briefly, due to its occurrence in Idaho.

Early (alkali) Sagebrush (*Artemisia longiloba*): Some references refer to early sagebrush as a variety of low sagebrush, or *Artemisia arbuscula*, (for example, see http://www.landfire.gov). However other authors consider it a separate species (Beetle 1960, Winward 2004, Rosentreter 2005). The color and morphology of *A. arbuscula* and *A. longiloba* are very similar (Winward 2004). Early sagebrush grows on shallow, ephemerally flooded soils, often with a claypan or skeletal rock layer near the surface (Robertson et al. 1966). It is frequently found in low-drainage areas of flats, plateaus, or tables (Rosentreter 2005). Early sagebrush is a prolific seed-producer and could be used for restoration in appropriate, shallow soil sites (Beetle and Johnson 1982, Monson and Shaw 1986). It "layers" and can re-sprout after cool fires (Rosentreter 2005). Rosentreter (2005) rated early sagebrush as highly palatable to sage-grouse and noted that some of the largest leks in Idaho are in areas dominated by this species. Early sagebrush flowers very early in the summer, in contrast to other low-statured species. Early sagebrush has also been confused with low-growing Wyoming big sagebrush because of its broadly cuneate (wedge-shaped) three-lobed leaves and with low sagebrush because of its dwarf size (Rosentreter 2005). It is

palatable to sheep and, historically, stands were commonly used as lambing areas (Beetle and Johnson 1982). Early sagebrush has also been referred to as "alkali sage".

Mean Fire Return Intervals in early sagebrush sites are similar to low sagebrush and are estimated by some sources to be 125 years (http://www.landfire.gov). Intervals may range from 40 years (Steinberg 2002) to more than 400 years (Baker, 2006) and are probably strongly related to the fire regimes of surrounding vegetation communities (http://www.landfire.gov).

Black Sagebrush (*Artemisia nova*)**:** Black sagebrush is a low-growing (4-12 inches high), multi-branched shrub (Winward 2004). It can commonly be identified by its persistent brownish colored flower stalks (Winward 2004, Rosentreter 2005). This species grows well on very shallow, stony soils, often on windswept slopes and ridges at mid- to high elevations (Behan and Welch 1985). It prefers calcareous or well-decomposed granitic soils that seem to mimic calcareous sites due to weathering of calcium feldspars. It occurs most abundantly from 4,900 to 7,000 ft in elevation where annual precipitation averages between 7 to 18 inches (McMurray 1986).

There appear to be at least two chemical races of black sagebrush in the West (McArthur and Plummer 1978; Kelsey 2002, personal communication). One race, with grayer leaves, is highly palatable while the greener-leafed race has low palatability (McArthur and Plummer 1978). This latter form does not fluoresce under UV-light; the former does, and was rated as highly palatable for sage-grouse (Rosentreter 2005). Black and low sagebrush communities can provide important winter, pre-laying and brood-rearing habitat for sage-grouse (Crawford et al. 2004). Most black sagebrush populations have leaf glands visible with a 10x hand lens (Kelsey and Shafizadeh 1980). Resin from these glands causes a stickiness when leaves are crushed (Winward 2004).

Mean fire return intervals for mixed severity fires in black sagebrush are estimated at 100-140 years, and 200-240 years for stand-replacing events (http://www.landfire.gov).

Low Sagebrush (*Artemisia arbuscula*): Low sagebrush is a low-growing shrub 8-16 inches in height (Winward 2004). It grows on shallow soils with a restrictive layer of bedrock or clay pan (Rosentreter 2004). Annual precipitation ranges from 7 to18 inches (Stevens 1983), but usually exceeds 12 inches (Rosentreter 2005). In Idaho, low sagebrush grows at approximately 6,000-9,800 ft (Schlatterer 1972). Soil parent material is non-calcareous (Rosentreter 2005). Black, early, Bigelow, Lahontan, and chicken sagebrush are often misidentified as low sagebrush (Rosentreter 2005). Low and black sagebrush communities can provide important winter, pre-laying and brood-rearing habitat for sage-grouse (Crawford et al. 2004). Low sagebrush is

readily consumed by sage-grouse (Klebenow 1973, Robertson 1986). Rosentreter (2005) rated low sagebrush as one of the most palatable sagebrushes for sage-grouse.

There is disagreement about fire frequency in low sagebrush communities. Estimates of mean fire return intervals range from 40 years (Steinberg 2002) to more than 400 years (Baker, 2006), and are probably strongly related to the fire regimes of surrounding vegetation (http://www.landfire.gov).

Budsage (*Artemisia spinescens or Picrothamnus desertorum*): Budsage grows on shallow, often saline soils at lower elevations and is frequently mixed with salt desert shrub vegetation (McWilliams 2003, Rosentreter 2005). It has spiny-tipped, thorn-like branches (Winward 2004), and reaches 4-10 inches in height (Institute for Land Rehabilitation 1979). It has palmately divided leaves that are deciduous. Budsage is considered to have low cover value for upland game birds (McWilliams 2003). Palatability for sage-grouse appears moderate, however its role with respect to sage-grouse use in Idaho is likely minor (Rosentreter 2005). Budsage communities rarely burn (McWilliams 2003). Specific information on fire regimes for bud sagebrush is not available, however they may be related to fire regimes of surrounding vegetation (McWilliams 2003).

Chicken Sage (*Tanacetum nuttallii*): Chicken sage grows on windswept benches and large flat areas with very shallow, calcareous gravels (Rosentreter 2005). It is woody with three-lobed leaves and a low (e.g. 4 inches tall) spreading growth form. It may be similar in appearance to a diminutive low sagebrush, hence its description here, but has smaller leaves (Rosentreter 2005). Sage-grouse can be found where this species is common, but use by sage-grouse is unknown (Rosentreter 2005).

2.2.2.3 Sub-shrub sagebrush types

The primary sub-shrub sagebrush types in Idaho include fringed sage and birdsfoot sage. In Idaho, fringed sagebrush is especially common in limestone-influenced valleys in the Challis and Salmon areas (R. Rosentreter, Botanist, BLM Idaho State Office, personal communication).

Fringed Sagebrush (*Artemisia rigida*): Fringed sagebrush is a small sub-shrub, woody only at the base. It occurs in a variety of soil types and depths but prefers shallow soils with “frigid” soil temperatures (Morris et al. 1976). Some sites are windswept and are readily available to wildlife in the winter. Studies in Montana (Peterson 1970, Wallestad et al. 1975) reported consumption of fringed sagebrush by sage-grouse, including juveniles. In Colorado’s Gunnison Basin, [Gunnison] sage-grouse have been observed feeding on fringed sage seedlings (Rosentreter 2005 citing J. Young, personal communication, Western State College, CO). Fringed

sagebrush is rated as moderately palatable (Rosentreter 2005) and may be an important sage-grouse food seasonally in parts of Idaho, especially in mid-elevation sites and upward (R. Rosentreter, Idaho BLM state office, personal communication). There is no specific information in the literature concerning fire regimes for fringed sagebrush (McWilliams 2003).

Birdsfoot Sagebrush (*Artemisia pedatifida*): Birdsfoot sagebrush is found in sagebrush-grass and saltbush (*Atriplex* spp.) (Goodrich and Neese 1986); it commonly occurs on alkaline soils (Morris et al. 1976). It is found from 5,200 to 5,900 ft on clay soils (Winward 2004). Information on fire regimes is not documented (Tirmenstein 1987). Rosentreter (2005) rated palatability to sage-grouse as low.

Chapter 3 – Status of Sage-grouse Populations and Habitat in Idaho

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3 Status of Sage-grouse Populations and Habitat in Idaho

3.1 Broad-scale

3.1.1 Statewide overview of population status

Sage-grouse have been monitored in Idaho since the 1950's, though in some areas, data are limited. Overall, from 1965-2003, Idaho's sage-grouse population declined at an average rate of 1.47% per year. The most dramatic decline occurred between 1965-1984, when the sage-grouse population declined by an average rate of 3.04% per year. Between 1985 and 2003, the average decline slowed, to 0.12% annually. In general, Idaho sage-grouse numbers reached a low in the mid 1990s but have increased since that time (Connelly et al. 2004).

Efforts to implement more comprehensive and consistent counts are ongoing. Over time, this should lead to more accurate data on short- and long-term population trends (see Chapter 5 for additional discussion).

3.1.2 Statewide overview of habitat status

3.1.2.1 Background

Landscape ecology is the study of spatial patterns and processes in the environment. An understanding of basic landscape ecology principles is essential for effective conservation planning for sage-grouse and other species since the effects of habitat loss and fragmentation on species' persistence can be substantial. For purposes of this Plan, habitat *loss* occurs when vegetation communities that previously provided suitable habitat, or had the potential to be restored to suitable habitat, are converted permanently or semi-permanently to non-habitat. Some examples include the replacement of sagebrush communities with towns, exurban home sites and intensive agriculture that has occurred along much of Idaho's Interstate Highway corridors and Snake River Plain.

Historically (ca 1850-1890), source habitats[1] for sage-grouse were widespread and continuous over much of the Interior Columbia Basin, particularly in the Columbia Plateau, Northern Great Basin, and Idaho's Owyhee Uplands and Upper Snake Ecosystem Reporting Units (ERUs). This assessment also reported that roughly 48% of the Interior Columbia Basin showed a decline in the extent of sagebrush habitat, with moderate declines estimated for the Owyhee Uplands, and extensive declines in the Upper Snake ERUs (Wisdom et al. 2000).

Agricultural development has played a role in the loss or fragmentation of sage-grouse habitat historically as well as in more recent years. For example, almost all of the basin big sagebrush (*Artemisia tridentata tridentata)* habitat on the Snake River Plain has been converted to cropland (Hironaka et al. 1983).

Habitat *fragmentation* results when larger, contiguous patches of habitat are broken into smaller, more disjunct patches (Morrison et al. 1998), and may or may not lead to habitat loss. For example, a series of wildfires might temporarily fragment a previously contiguous area of sagebrush that provided nesting habitat, but the burned areas may eventually become suitable again naturally or through rehabilitation. In contrast, a ranchette placed within a sagebrush patch is for all intents and purposes permanent, leading to a loss of habitat. Numerous factors interact to influence the response of wildlife to such fragmentation, including habitat patch size and shape, inter-patch distance, edge length and composition, species natural history, patch composition, vegetation structure, and others (Morrison 2002). If fragmentation progresses, patches may eventually may become too small to sustain a local population or even individual territories (Fahrig 2003). Also, as fragmentation increases, time spent in the surrounding unsuitable habitat also increases, which may lead to higher mortality rates or decreased productivity (Fahrig 2002). Fragmentation effects on songbirds [and possibly sage-grouse] in shrubland or grassland systems may be most evident in situations where disturbance of a previously homogenous habitat results in a highly contrasting mosaic of suitable and unsuitable habitats, and less so in areas that are naturally heterogeneous (Knick and Rotenberry 2002).

While some basic principles of landscape ecology are described below, further reading is recommended. In addition to the citations noted in this section, other recommended references include Bissonette (1997), Forman (1995), Gutzwiller (2002), and Morrison et al. (1998). Dramstad et al. (1996) provide a very readable, and concise handbook of landscape ecology, and is recommended preliminary

[1] Note: the term "source habitat" is used in this particular quote as defined in the Interior Columbia Basin Ecosystem Management Plan or ICBEMP as "Those characteristics of macro vegetation that contribute to stationary or positive population growth. Distinguished from habitats associated with species occurrence; such habitats may or may not contribute to long-term population persistence.

reading. Selected key principles illustrated in the book, that conservation planners and habitat managers should be aware of regarding the effects of habitat fragmentation on wildlife are presented below. An interpretation of how each principle applies to sage-grouse conservation planning in Idaho has been added.

- *"The probability of a species becoming locally extinct is greater if a patch is small, or of low habitat quality."*
    - Interpretation: Sage-grouse populations occupying areas where more extensive sagebrush habitats have become fragmented into smaller patches, or where habitat quality is low are at risk.
- *"The probability of a species going locally extinct is greater in an isolated patch. Isolation is a function not only of distance, but also of the characteristics (i.e., resistance) of the intervening matrix habitat."*
    - Interpretation: Sage-grouse populations that are isolated from other populations due to large distances and/or unsuitable surrounding habitats are at greater risk of extirpation than populations that can interact.
- "*Removal of a patch causes habitat loss, which often reduces the population size of a species dependent upon that habitat type, and may also reduce habitat diversity, leading to fewer species.*"
    - Interpretation: As areas (patches) of sage-grouse habitat are lost, such as due to cheatgrass conversion, wildfire or other factors, the ability of the landscape to support sage-grouse populations, or other species, may be reduced.
- "*Removal of a patch reduces the size of a metapopulation (i.e., an interacting population subdivided among different patches) thereby increasing the probability of local within-patch extinctions, slowing down the recolonization process, and reducing stability of the metapopulation*."
    - Interpretation: Loss of habitat patches can hinder the ability of nearby sage-grouse populations to interact or expand.

The loss and fragmentation of sage-grouse habitat in some parts of Idaho are of major concern. Connelly et al. (2004) provided a broad-scale, rangewide analysis of a variety of factors, including a composite analysis of the "human footprint" on the landscape. Fragmentation by anthropogenic features in the Snake River Plain was considered high.

Detailed habitat fragmentation studies in Idaho are scarce. In southwestern Idaho, Knick and Rotenberry (1997) evaluated the effects of various disturbances on landscape characteristics. Fragmentation patterns due to a combination of wildfire and agriculture, or with repeated fires originating from military training, resulted in a landscape where natural recovery of shrublands is likely slow. The presence of cheatgrass, which shortens fire-return intervals and hinders shrubland recovery efforts, was more likely in areas containing high proportions of shrubland/grassland edge or in small shrubland patches. These small shrubland patches, with little interior area, are likely to be completely removed by wildfire, since cheatgrass can easily invade the entire patch (Knick and Rotenberry 1997, Knick and Rotenberry 2000). More recently, Shepherd (2006), examined sage-grouse habitat-use in fragmented and unfragmented habitats in southern Idaho.

3.1.2.2 Fragmentation analysis

Due to the limited availability of landscape-level habitat fragmentation analyses for Idaho, we completed a preliminary analysis described below. Landscapes and ecosystems are complex, thus no single measure of habitat fragmentation should be relied upon in and of itself (Davidson 1998). While numerous techniques are available to describe and quantify aspects of habitat fragmentation, *sagebrush-grassland edge density* and *sagebrush aggregation index* appeared to provide two relatively straightforward and meaningful factors to analyze and portray graphically. The primary purpose of the analysis was to provide LWGs and LWG startup teams additional information, which is not otherwise readily available, to aid in identifying general areas where sage-grouse/sagebrush habitat fragmentation may be of particular concern and thus where they might consider focusing restoration efforts or further study. We used the USGS 2005 Shrubmap digital landcover dataset as a foundation for the analysis. While this analysis provides a general idea of fragmentation patterns, subsequent analyses should be considered as the quality of digital landcover imagery evolves and becomes available. Finer scale (e.g., watershed or other) analyses should also be considered where habitat fragmentation is of particular concern. Quantification of other metrics such as number of sagebrush patches, sagebrush patch size, or other measures of interest may be valuable.

3.1.2.2.1 Edge density

Edge density (ED) is expressed as the total length of patch edge per unit area (McGarigal and Marks 1995). In this analysis, we focused on ED between sagebrush and grassland vegetation covertypes. By definition, areas of high sagebrush-grassland ED are more fragmented than areas of low sagebrush-grassland ED (i.e.,

contiguous sagebrush). Also, areas of high ED are likely at greater risk for rapid invasion of cheatgrass into sagebrush patches, and wildfire effects (Knick and Rotenberry 1997). When portrayed on a map as a gradient of color (high to low ED), the information can help identify areas where the degree of habitat fragmentation may or may not be of potential concern. While the threshold value at which sagebrush-grassland ED becomes detrimental to sage-grouse is currently unknown, the species' dependence on sagebrush suggests that areas of higher ED may be at risk and warrant additional site-specific analyses.

3.1.2.2.1.1 Edge density methods

Sagebrush-grassland ED was quantified in ft/acre and spatially mapped across all SGPAs using GIS in conjunction with the computer program FRAGSTATS[2] Version 3 (McGarigal et al. 2002). For a base vegetation map, we reclassified the USGS 2005 Shrubmap regional landcover dataset[3], by collapsing the covertypes into four classes, "Sagebrush", "Grassland", "Pinyon-Juniper", and "Other." "Sagebrush" is defined in Shrubmap as a pixel (30 x 30 m) comprised of at least 10% total shrub cover, with sagebrush being the dominant shrub. The aggregated "Sagebrush" class included all sagebrush types in Shrubmap, relevant to Idaho. The aggregated "Grassland" class included all perennial and annual grassland types defined by Shrubmap, as well as those defined as "recently burned." Pinyon-juniper types were also combined as a single class due to interest in this covertype in Idaho. All remaining covertypes were combined into a single class labeled "Other." Neither "pinyon-juniper" nor "Other" classes were included in the ED analysis, though they were portrayed in the final map product for reference. We completed an accuracy assessment (Table 3-1) of the reclassified, combined covertypes, based on an evaluation of accuracies published for USGS Shrubmap. User accuracies for most covertype classes was acceptable (>75%). For the ED map product, ED was calculated using a 180 m moving window, within which the linear interface of sagebrush and grassland covertypes was quantified. While any range of moving window search radii could have been utilized, 180 m, in contrast to 1000 m, appeared to yield more meaningful map resolution.

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[2] FRAGSTATS is a computer software program designed to compute a variety of landscape metrics. The original version was released to the public domain in 1995 as a USDA Forest Service General Technical Report (McGarigal and Marks. 1995), and has since been updated. [http://www.umass.edu/landeco/]

[3] A new regional vegetation cover dataset, "Shrubmap" was published in September 2005 on SAGEMAP. The longer title is "*Current distribution of sagebrush and associated vegetation in the Columbia Basin and Southwestern Regions*". Multi-season satellite imagery, using 1999-2003 Landsat 7 ETM+, and digital elevation model derived datasets (e.g. elevation, landform, aspect, etc.) were used to derive rule sets for the various landcover classes. For additional details, review the associated metadata also posted on SAGEMAP. [http://sagemap.wr.usgs.gov/]

Table 3-1 Accuracy (%) assessment for reclassified USGS Shrubmap covertypes used in the edge density and contagion analysis.

Shrubmap Geographic Area	SGPAs Represented	Grassland	Sagebrush	Pinyon-Juniper	Other	Overall
Southeast Idaho	Curlew, EIU, SMV	46.15	81.93	75.00	87.31	81.40
Lost River	US, Chal	62.50	89.82	100.00	97.84	93.37
Snake River Plain	WC, MH, WMV, EMV, BD	96.67	93.04	100.00	97.42	95.27
Sawtooth	N/A	70.27	84.77	N/A	93.05	88.37
Owyhee Uplands *	Ow, Jar, SB	100	100	100	100	100
Basin and Range*	Ow	83.33	95.27	100.00	93.75	94.48

* Comparatively few validation sites were available in these areas. Refinement of the landcover map using additional information is in progress.

3.1.2.2.1.2 Edge density results

Sagebrush-grassland ED is shown in Figure 3-1 for all SGPAs. Areas of high grassland-sagebrush ED are portrayed as orange-red. These areas imply relatively high sagebrush/grassland interface or patchiness and greater risk to sage-grouse habitat integrity. Opportunities may exist for restoration however, as sagebrush seed sources are present. Protection from wildfire coupled with sagebrush restoration efforts could eventually decrease sagebrush patchiness, though understory quality needs to be considered as well. Where these areas also interface with larger, (yellow) grasslands, impacts on sage-grouse may be of particular concern, due to the apparent limited availability of sagebrush on the landscape (e.g., see especially, portions of the West Central, East Magic Valley, Big Desert, Jarbidge).

Extensive areas with low sagebrush-grassland ED (dark green) are also evident, such as in most of the Upper Snake and Challis SGPAs, as well as portions of other SGPAs. Maintaining the integrity of these larger sagebrush landscapes should be considered a management priority. The interpretation of ED for some parts of the state, such as southeastern Idaho should be done with caution, as user accuracy for grasslands is low compared to other parts of the state (Table 3-1).

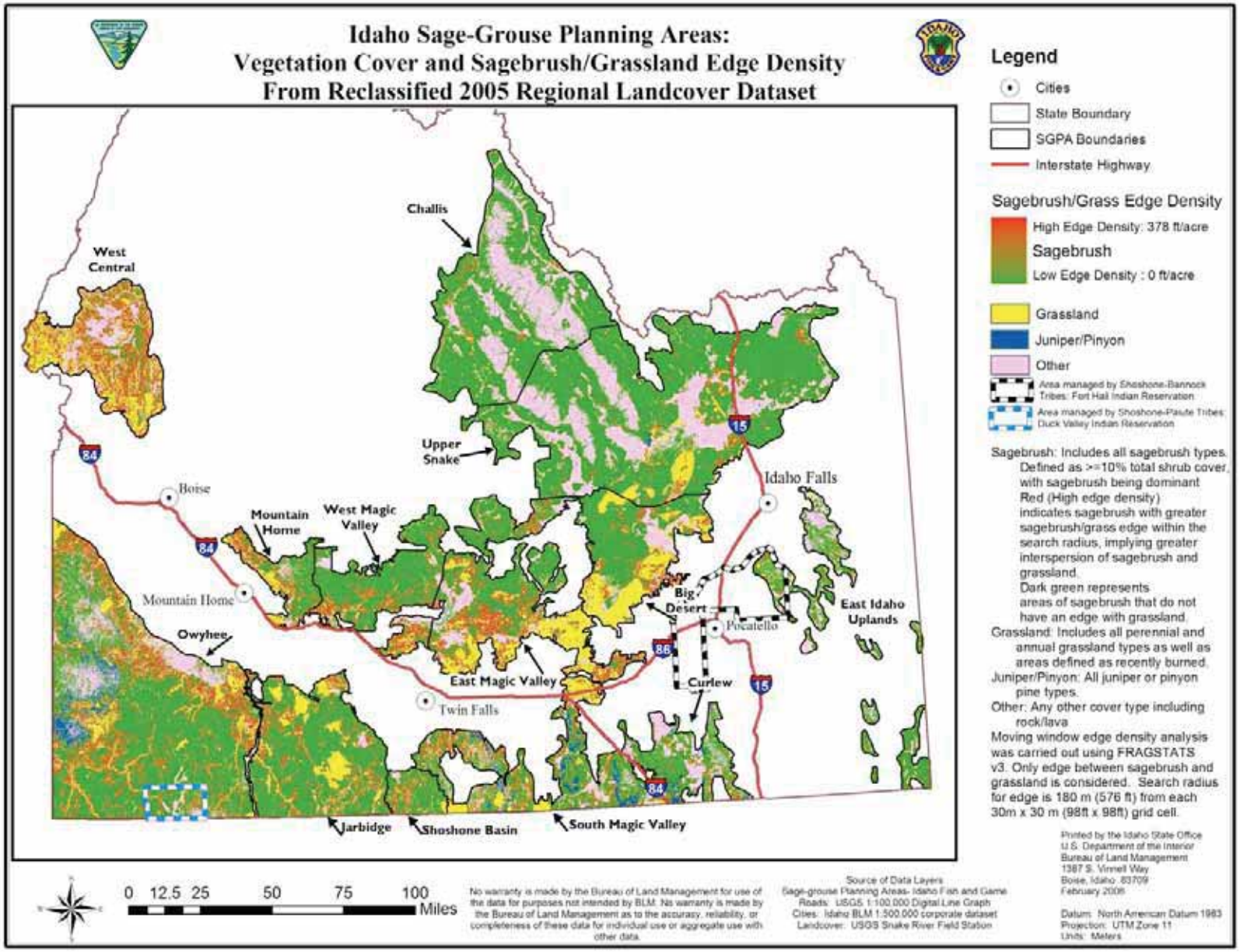

Figure 3-1 Idaho Sage-grouse Planning Areas: Vegetation cover and sagebrush/grassland edge density from reclassified 2005 regional landcover dataset.

3.1.2.2.2 Aggregation Index

For this analysis, aggregation index, or AI, (He et al. 2000) provides a means of evaluating the clumpiness or aggregation of sagebrush covertypes on the landscape. Areas with high AI reflect a high degree of adjacency of sagebrush map pixels, and therefore a high degree of aggregation. Areas with low AI occur when pixels show little adjacency, and thus are disaggregated. While the edge density analysis quantified sagebrush-grassland edge, sagebrush AI reflects the degree of aggregation of sagebrush, independent of other vegetation classes. AI values range from 0% (i.e., no adjacency of sagebrush pixels, and high fragmentation or patchiness) to 100% (i.e., maximum aggregation, with contiguous sagebrush). By definition, areas of high sagebrush AI are more contiguous and thereby less fragmented than are areas of low sagebrush AI. Areas with a high AI are assumed to provide more available sagebrush for sage-grouse than areas of low AI, though ecological site potential plays a role. That is, while some areas may reflect a low AI due to fragmentation of sagebrush communities due to wildfire or human impacts, other areas may naturally have a low sagebrush AI due to variability in site potential and a diversity of covertypes.

When portrayed on a map as a gradient of color from low AI (red) to high AI (dark green), the information can help identify areas where sagebrush aggregation (or lack thereof), may or may not be of potential concern. While the threshold value at which lower sagebrush AI's becomes detrimental to sage-grouse is currently unknown, the species' dependence on sagebrush suggests that areas of lower AI may provide less desirable habitat and warrant additional site-specific analyses, again, assuming the site potential should otherwise support a greater extent of sagebrush.

3.1.2.2.2.1 Aggregation index methods

Sagebrush AI was quantified and spatially mapped across all SGPAs using GIS in conjunction with the computer program FRAGSTATS[4] Version 3 (McGarigal et al. 2002). For a base vegetation map, we reclassified the USGS 2005 Shrubmap regional landcover dataset[5], by collapsing the covertypes into two classes, "Sagebrush", and

[4] FRAGSTATS is a computer software program designed to compute a variety of landscape metrics. The original version was released to the public domain in 1995 as a USDA Forest Service General Technical Report (McGarigal and Marks. 1995), and has since been updated. [http://www.umass.edu/landeco/]

[5] A new regional vegetation cover dataset, "Shrubmap" was published in September 2005 on SAGEMAP. The longer title is "*Current distribution of sagebrush and associated vegetation in the Columbia Basin and Southwestern Regions*". Multi-season satellite imagery, using 1999-2003 Landsat 7 ETM+, and digital elevation model derived datasets (e.g. elevation, landform, aspect, etc.) were used

"Other". "Sagebrush" is defined in Shrubmap as a pixel (30 x 30 m) comprised of at least 10% total shrub cover, with sagebrush being the dominant shrub. The aggregated "Sagebrush" class included all sagebrush types in Shrubmap, relevant to Idaho. All remaining covertypes were combined into a single class labeled "Other." The "Other" class was not analyzed for AI, though it appears in the final map product for reference. See Table 3-1 and the related discussion in edge density for information related to the accuracy assessment of the collapsed sagebrush covertypes. For the AI map product, AI was calculated using a 180 m moving window.

3.1.2.2.2.2 Aggregation index results

Sagebrush AI was spatially portrayed across all SGPAs as a color gradient from low AI (red) to high AI (green) (Figure 3-2). Red areas imply relatively higher sagebrush patchiness and greater risk to sage-grouse habitat integrity. In these areas, opportunities may exist for restoration and expansion of sagebrush aggregation, since sagebrush seed sources are present. However understory quality needs to be considered as well. As with the higher sagebrush-grassland edge density areas, protection from wildfire coupled with appropriate restoration efforts could eventually increase AI (i.e., increase sagebrush aggregation). All SGPAs harbor at least some areas of low AI (red; low degree of sagebrush aggregation), but in some (e.g., West Central, Owyhee, East Magic Valley, South Magic Valley) some extensive areas are evident.

Relatively extensive areas with higher sagebrush AI (dark green; high sagebrush aggregation) are also evident, such as in much of the Upper Snake, and Challis and portions of the Big Desert, West Magic Valley, Jarbidge and Owyhee SGPAs. Maintaining the integrity of these larger sagebrush landscapes should be considered a management priority.

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to derive rule sets for the various landcover classes. For additional details, review the associated metadata also posted on SAGEMAP. [http://sagemap.wr.usgs.gov/]

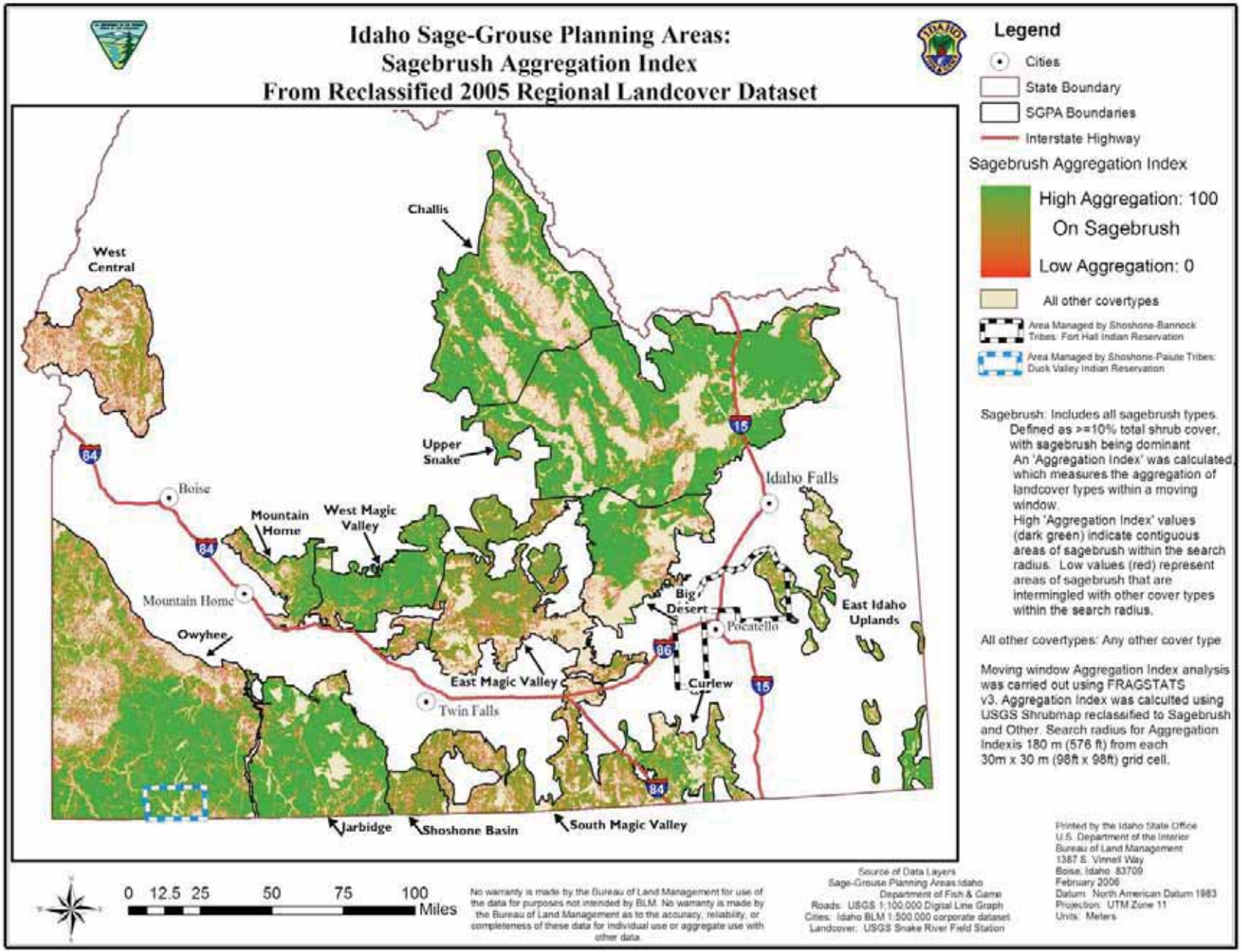

Figure 3-2 Idaho Sage-grouse Planning Areas and sagebrush aggregation index from reclassified 2005 regional landcover dataset.

3.1.2.2.3 Fragmentation analysis summary

The information provided here should be considered preliminary, due to the broad-scale nature of the analysis, and limitations in thematic map imagery. Where apparent high edge densities of sagebrush-grassland vegetation types, and/or where low sagebrush aggregation indices have been identified, LWGs should pursue further analyses and field mapping at finer scales (e.g., 1:100,000 to 1:24,000). This is necessary since, in some cases, these index values may be a function of local ecological site variability or mapping/ imagery errors. Alternatively, they may be driven by factors such as cheatgrass, wildfire or human activities that warrant management intervention.

3.2 Mid-scale

Spatial analysis of sage-grouse habitat in Idaho, based on a gross comparison of historical habitat (Schroeder et al. 2004), with Idaho's 2004 Sage Grouse Habitat Planning Map suggest that approximately 14.5 million (14,522,755) acres of sage-grouse habitat have been lost, with approximately 13.3 million acres of key habitat and potential restoration areas (perennial grasslands, annual grasslands, conifer encroachment areas) remaining (USDI BLM 2004a). The majority (63%) of current key sage-grouse habitat in Idaho is comprised of lands administered by the BLM. Private lands collectively comprise a smaller though significant proportion (19%) of key habitat. State, USFS, and DOE lands collectively provide 18%. Other land ownerships (National Park Service [NPS], Bureau of Indian Affairs [BIA], Department of Defense [DOD], and USFWS) collectively contribute approximately 1% (Table 3-2).

Table 3-2 Extent of existing key sage-grouse habitat in Idaho as of June 2004[6]

Land status	Acres by status	Percent of total
BLM	5,684,923	63
Private	1,705,475	19
State	636,712	7
USFS	502,439	6
DOE	385,227	4
Other	98,116	1
Total	**9,012,892**	**100**

[6] Source: USDI-BLM 2004*a*.

3.2.1 SGPA population and habitat status

The following information summarizes the status of sage-grouse habitat and populations by each of Idaho's 13 SGPAs, based on the best-available information.

3.2.1.1 Background population status

Population trend information for sage-grouse is conducted by recording the high count of males on established leks or lek routes each spring. The quality of lek data in Idaho varies greatly. Data for some areas has been collected consistently for many years. In other areas, data were collected inconsistently, thus not allowing an accurate evaluation of population trends. In this section, lek data are presented for areas where lek routes have been consistently monitored for at least 20 years. Although most SGPA's have inconsistent counts, all lek data should be carefully evaluated by each LWG to determine its quality and what might be done to improve collection of lek data using the techniques outlined in Chapter 5.

3.2.1.2 Background habitat Status

Habitat figures and SGPA maps shown in the sections to follow reflect several broad covertypes and land ownership status, based on the 2004 version of the Idaho Sage-grouse Habitat Planning Map. This map was initially developed cooperatively by BLM, IDFG and other partners in 2000, to facilitate wildland fire suppression planning and other habitat conservation efforts. It has been periodically updated and refined, based on annual wildfire activity and other factors. Accuracy and precision of the map varies. Some polygons, such as certain perennial or annual grasslands resulting from recent wildfires reflect relatively high precision and accuracy, since boundaries of BLM rangeland wildfires are routinely mapped using GPS and GIS technology. Large areas of the map, however, represent only the best current approximation of general habitat status, based on interdisciplinary or interagency input.

The map is a work in progress and will continue to evolve as mapping technology improves and as habitat changes occur. It will be up to each LWG to identify needed changes, alterations, or additions to the current habitat planning maps during the scheduled annual updates each fall/winter so that appropriate changes can be made in a timely manner prior to the next field (fire) season. See the Chapter 5 for additional details.

Covertype definitions include:

- ***e a e r e a tat*:** Areas of generally intact sagebrush that provide sage-grouse habitat during some portion of the year.

- ***te t a e t rat rea*:**
  - Type I. Perennial Grassland: Sagebrush-limited areas characterized by perennial grass species composition and/or structure that should provide suitable potential nesting habitat in the future, once sufficient sagebrush cover is re-established (at least 10% canopy cover). Includes areas characterized by native and/or introduced perennial bunchgrasses.

  - Type II. Annual Grassland: Areas dominated or strongly influenced by invasive annuals such as cheatgrass (*Bromus tectorum*) or medusahead rye (*Taeniatherum caput-medusae*) or similar species. Areas with sagebrush may be present, but, in general, understories are not suitable for sage-grouse. Reclassify as Perennial Grassland once restoration seedings are determined to be successful.

  - Type III. Conifer Encroachment: Areas where junipers (*Juniperus* spp.) and/or other conifer species are encroaching into sage-grouse habitat areas.

Acreage figures reported below reflect approximate total acreages of combined Key and Potential Restoration Areas within each SGPA, and proportion of this total, by land ownership. Areas of non-habitat are excluded in order to focus planning efforts on habitats relevant to sage-grouse. Consequently, total acreage and land status figures reported below for some SGPAs are less than if all lands and habitats within the SGPA boundaries had been included.

The habitat figures were derived from the July 2004 edition of the Idaho Sage-grouse Habitat Planning map via GIS query (USDI-BLM 2004*a*). The 2004 edition incorporated fire polygons through the 2003 fire season and is not inclusive of fires or other habitat alterations that may have occurred in summer 2004 or later. It does, however, incorporate several relatively minor polygon edits suggested in spring 2004 for portions of the Upper Snake; Big Desert; and East, West, and South Magic Valley SGPAs. Because of the fluid nature of habitat conditions and landscape threats such as wildfire, and time-lags associated with annual updates to the map, acreage figures reported here are mainly for context, and should not be considered as absolute.

3.2.1.3 Big Desert SGPA

3.2.1.3.1 Population

Figure 3-3 shows the average number of males per lek counted (includes all leks counted with zeros) from 1964-2005. The data used to develop Figure 3-3 includes all lek counts along the Big Desert lek routes (Big Desert # 1, Big Desert # 3, Big Desert # 5, South Big Desert, and Fingers Butte).

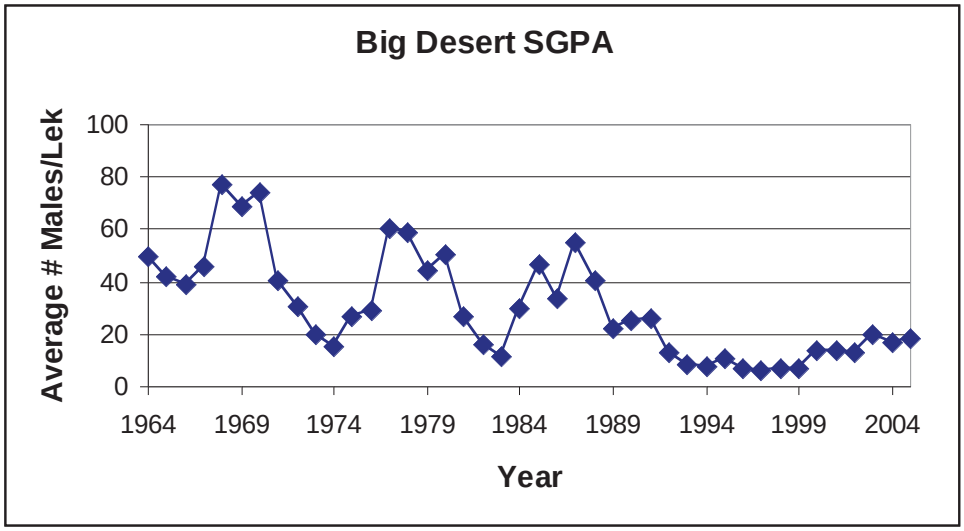

Figure 3-3 Changes in average number of males/lek 1964-2005, Big Desert Sage-grouse Planning Area.

3.2.1.3.2 Habitat

The sage-grouse habitat within the Big Desert SGPA (Figure 3-4) is about 850,000 acres in size. Thirty-four percent of the area is classified as key sage-grouse habitat, 51% is dominated by perennial grassland and 15% is annual grasslands. The Bureau of Land Management (including lands within the Craters-of-the-Moon National Monument boundary) administers 76% of the sage-grouse habitat within the area, 7% is administered by the Department of Energy, 7% is private, 10% is managed by the State, and <1% is managed by the National Park Service.

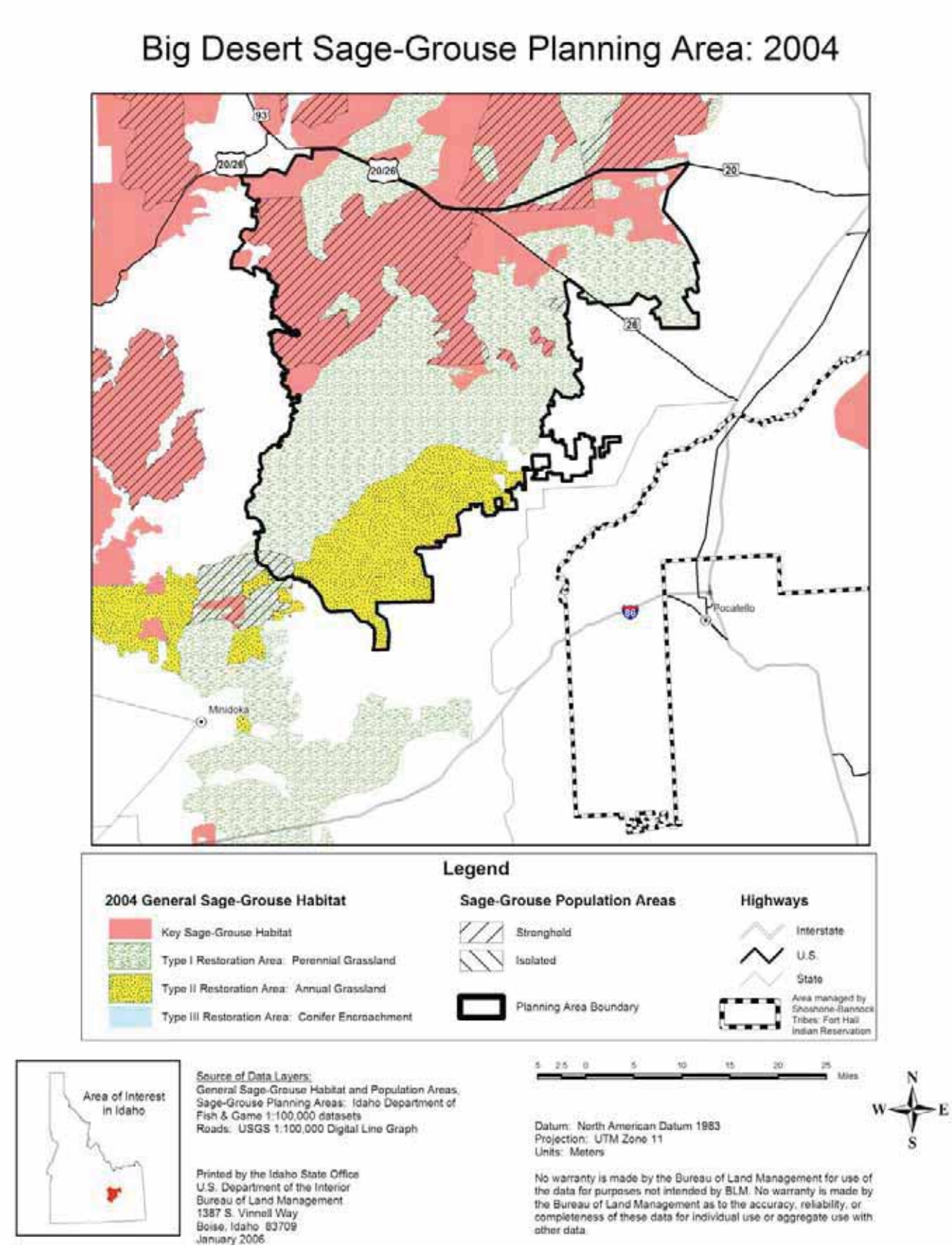

Figure 3-4 Map of Big Desert Sage-grouse Planning Area, 2004

3.2.1.4 Challis SGPA

3.2.1.4.1 Population

Lek data collected within the Challis SGPA are too inconsistent to develop a trend graph. Some individual leks were counted annually between 1985 and 2005 in the Lemhi drainage. However, the individual leks were part of established lek routes that were not all counted on the same morning.

3.2.1.4.2 Habitat

The sage-grouse habitat within the Challis SGPA (Figure 3-5) is about 878,000 acres in size. The Bureau of Land Management administers 81% of the sage-grouse habitat within the area, 9% is private, 5% is managed by the State, and 5% is administered by USDA Forest Service. Ninety-nine percent of the area is classified as key sage-grouse habitat and 1% is dominated by perennial grassland. Conifer Encroachment Areas likely exist, but have not been incorporated into the Sage-Grouse Habitat Planning Map as of 2004. It should be noted that the Challis and Upper Snake LWG Plans both address habitat in the Big Lost drainage, from Willow Creek Summit to Pass Creek.

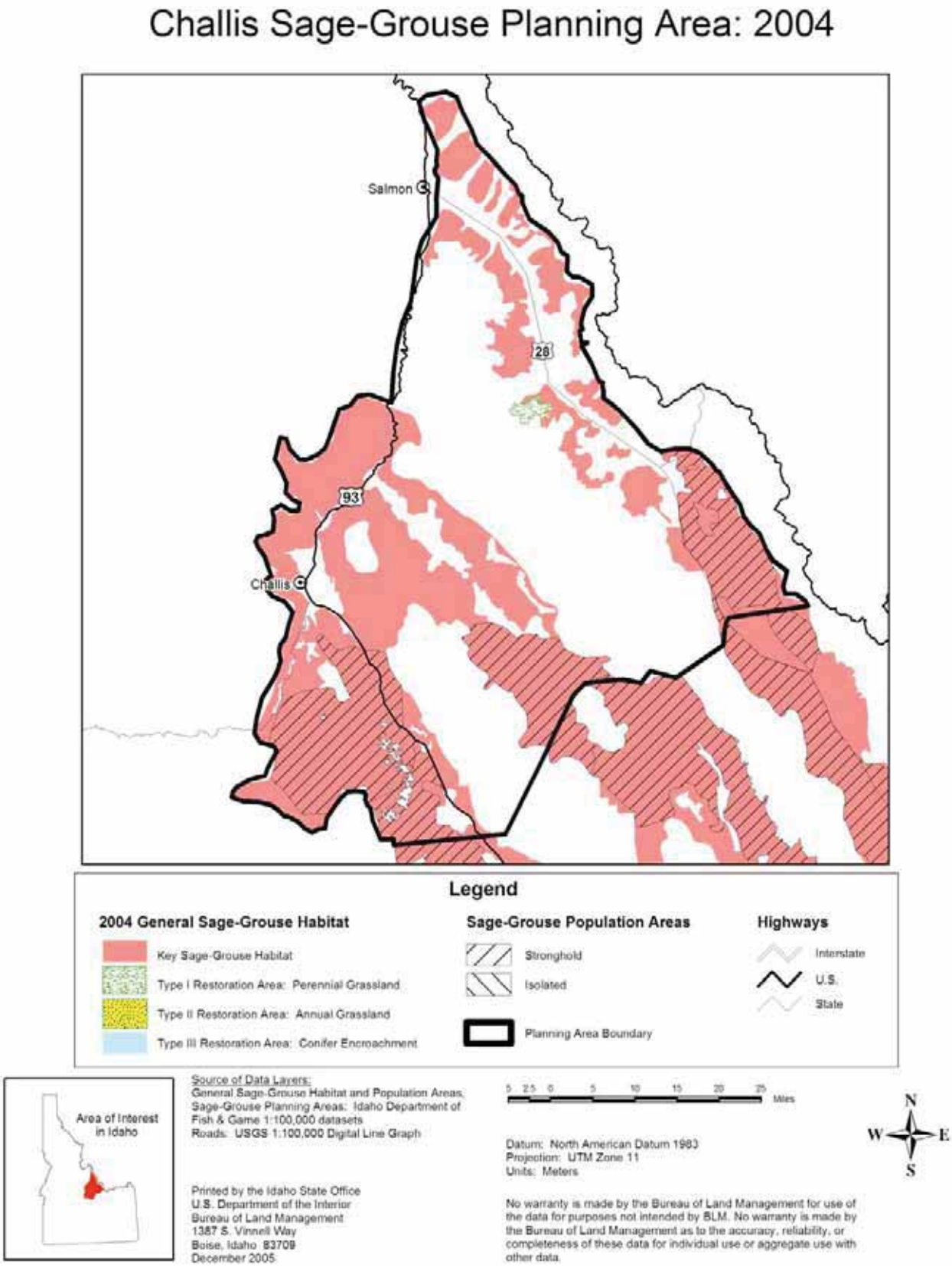

Figure 3-5 Map of Challis Sage-grouse Planning Area, 2004

3.2.1.5 Curlew SGPA

3.2.1.5.1 Population

Lek data collected within the Curlew SGPA are too inconsistent to develop a trend graph. Two lek routes established during the late 1980s (Curlew and Rockland) were not counted annually until 1996.

3.2.1.5.2 Habitat

The sage-grouse habitat within the Curlew SGPA (Figure 3-6) is about 394,000 acres in size. The Bureau of Land Management administers 53% of the sage-grouse habitat within the area, 30% is private, 3% is managed by the State, and 14% is managed by USDA Forest Service. Seventy-two percent of the area is classified as key sage-grouse habitat, 26% is dominated by perennial grassland, and 2% is conifer encroachment area.

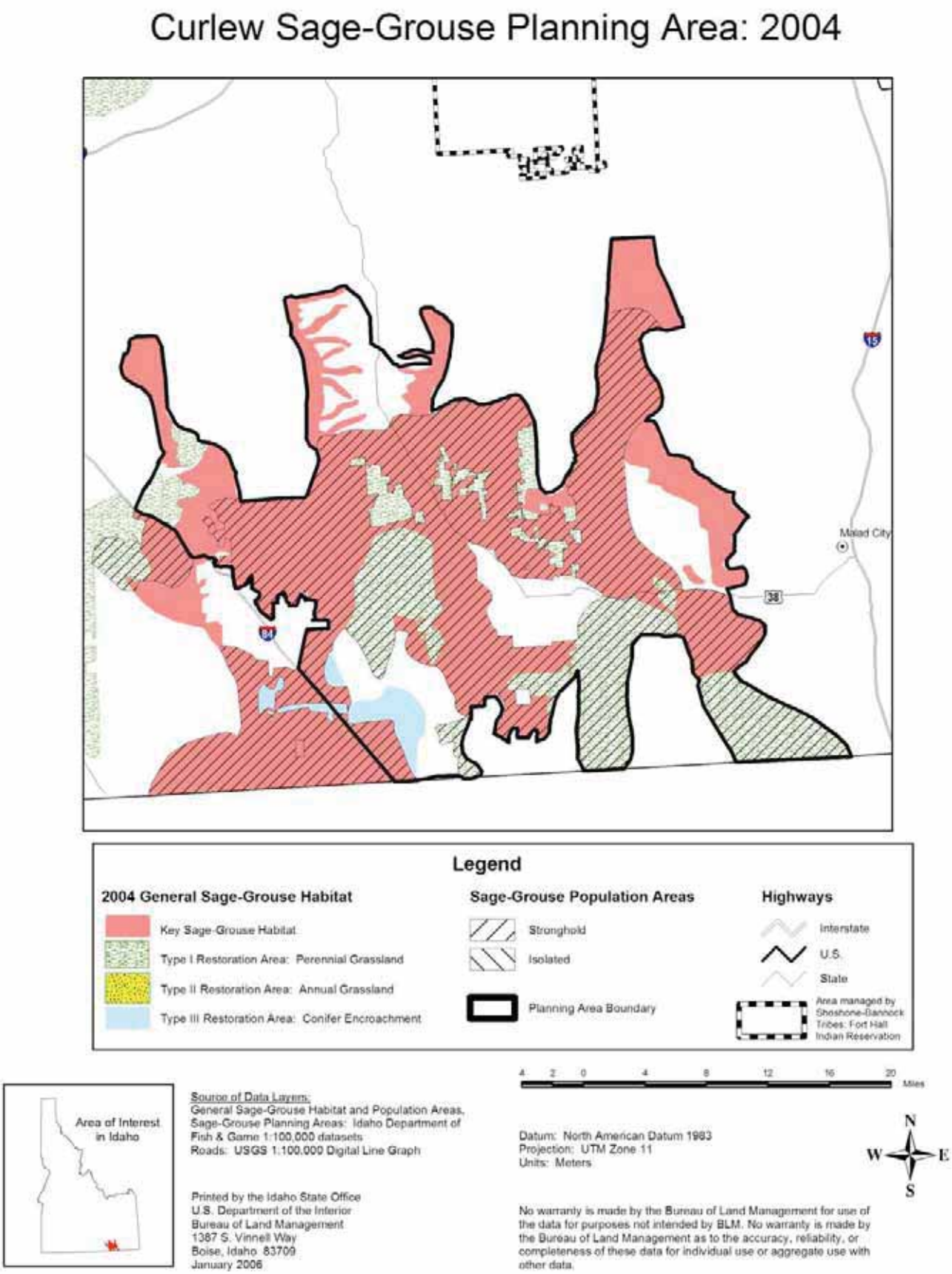

Figure 3-6 Map of Curlew Sage-grouse Planning Area, 2004

3.2.1.6 East Idaho Uplands SGPA

3.2.1.6.1 Population

Only one lek route was established within the East Idaho Uplands SGPA. This route, in Caribou County, east of Soda Springs was consistently counted from 1980-2003. Figure 3-7shows the average number of males/lek (includes lek counts with zeros) within the Caribou County lek route only. Other leks have been counted sporadically in Bear Lake and Bingham Counties. However, there is not enough information to document trends for the rest of the SGPA.

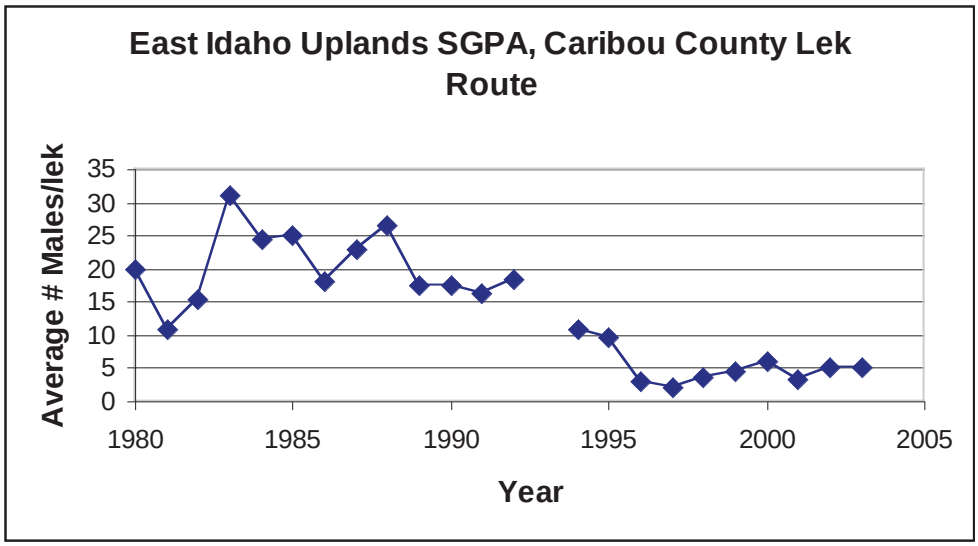

Figure 3-7 Changes in average number of males/lek 1980-2003, Caribou County lek route within the East Idaho Uplands Sage-grouse Planning Area.

3.2.1.6.2 Habitat

The sage-grouse habitat within the East Idaho Uplands SGPA Planning Area (Figure 3-8) is about 520,000 acres in size and encompasses numerous isolated areas of sagebrush (mountain ranges weave in and out of sagebrush meadows). BLM manages approximately 15% of the SGPA; 56% is private, 16% is managed by the State, and 2% is administered by the Bureau of Reclamation. Approximately 11% of the SGPA occurs within the boundaries of the Fort Hall Indian Reservation, an area managed by the Shoshone-Bannock Tribes. The USDA Forest Service and U. S. Fish and Wildlife Service administer less than 1%. Ninety-seven percent of the planning area is classified as key sage-grouse habitat and 3% is annual grasslands.

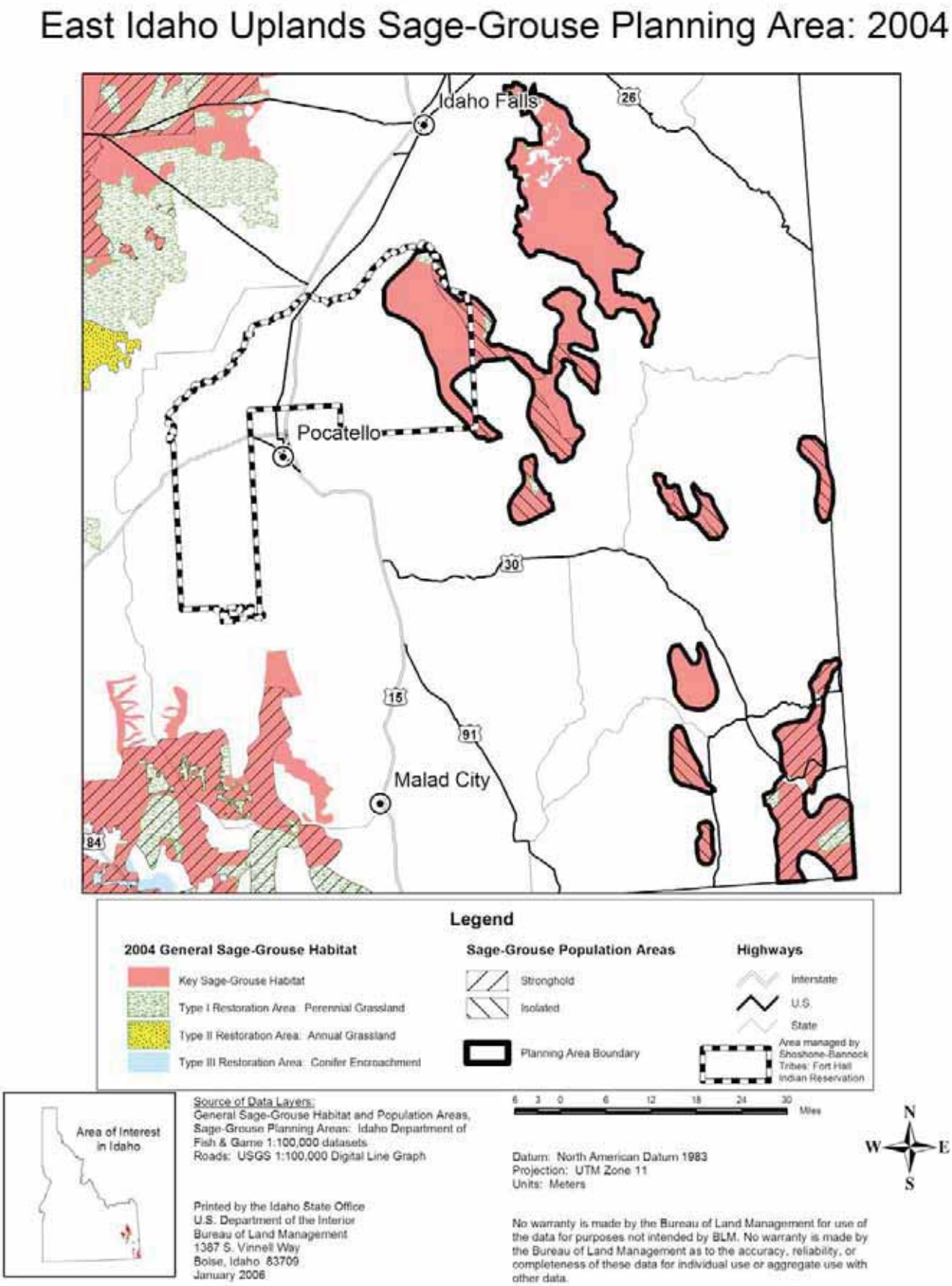

Figure 3-8 Map of East Idaho Uplands Sage-grouse Planning Area, 2004

3.2.1.7 East Magic Valley SGPA

3.2.1.7.1 Population

Figure 3-9 shows the average number of males per lek counted (includes all leks counted with zeros) from 1979-2005. The data used to develop Figure 3-9 includes all lek counts along the East Magic Valley lek routes (Timmerman, Paddleford Flats, Picabo, and Lincoln Minidoka).

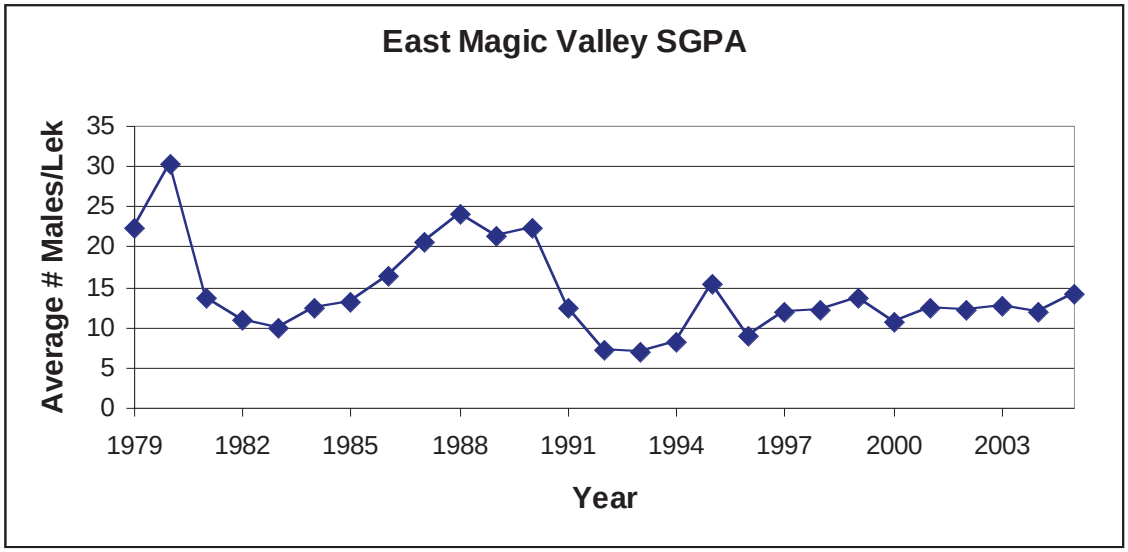

Figure 3-9 Changes in average number of males/lek 1979-2005, East Magic Valley Sage-grouse Planning Area.

3.2.1.7.2 Habitat

The sage-grouse habitat within the East Magic Valley SGPA (Figure 3-10) is about 1.3 million acres in size. The Bureau of Land Management (including BLM lands within the Craters-of-the-Moon National Monument boundary) administers 80% of the sage-grouse habitat within the area, 2% is managed by the National Park Service, 12% is private, and 6% is managed by the State. Less than 1% of the area is administered by USDA Forest Service, U.S. Fish and Wildlife Service, and other. Forty-two percent of the area is classified as key sage-grouse habitat, 39% is dominated by perennial grassland, and 19% is annual grasslands.

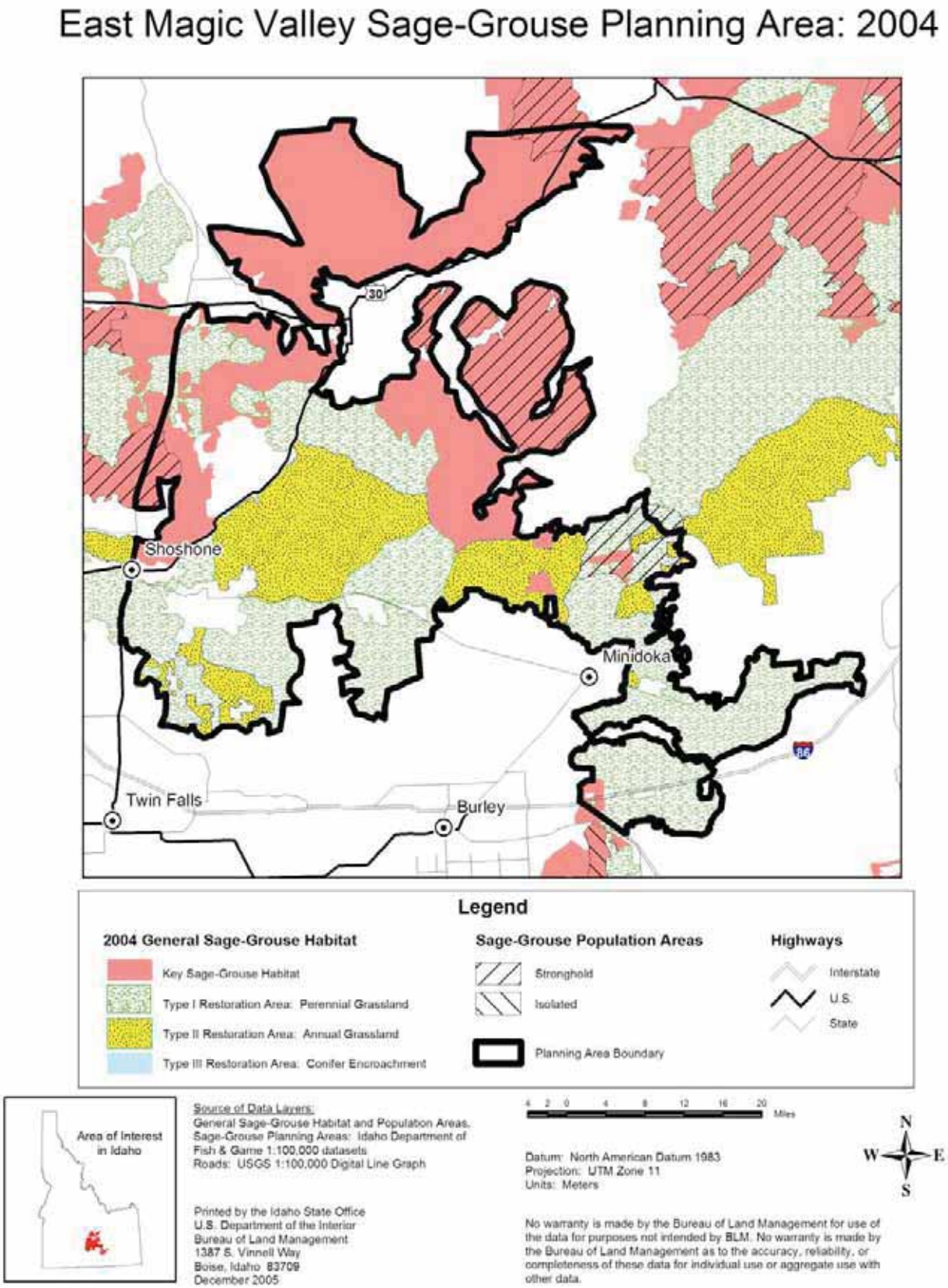

Figure 3-10 Map of East Magic Valley Sage-grouse Planning Area, 2004

3.2.1.8 Jarbidge SGPA

3.2.1.8.1 Population

Lek data within the Jarbidge SGPA are too inconsistent to develop a trend graph. One lek route (Brown's Bench) located on the eastern edge of the SGPA has had consistent counts since 1992.

3.2.1.8.2 Habitat

The sage-grouse habitat within the Jarbidge SGPA (Figure 3-11) is about 1.2 million acres in size. The Bureau of Land Management administers 85% of the sage-grouse habitat within the area, 7% is private, 5% is managed by the State, and 3% is managed by the Department of Defense. Forty-nine percent of the planning area is classified as key sage-grouse habitat, 51% is dominated by perennial grasslands, and <1% is annual grasslands.

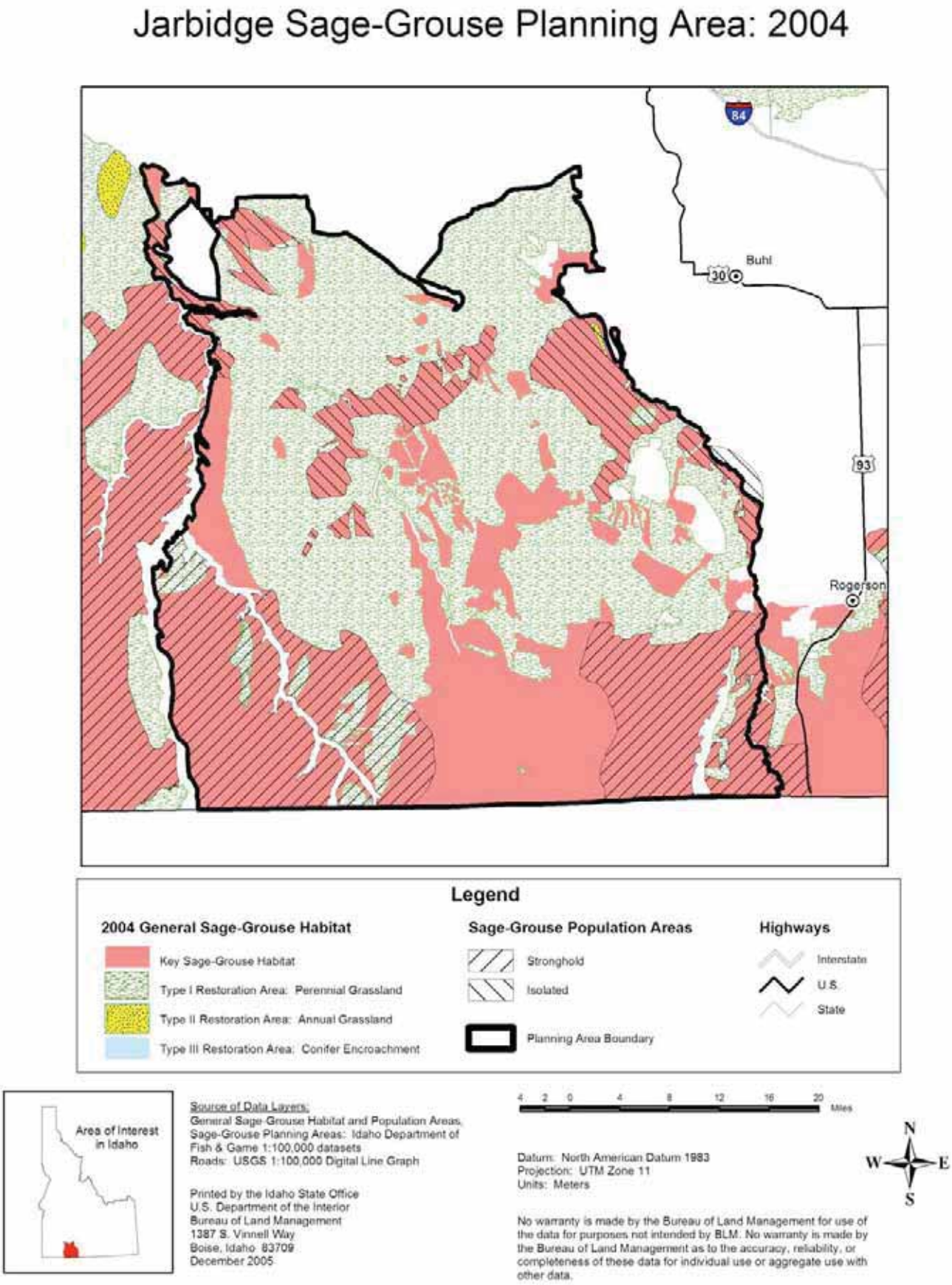

Figure 3-11 Map of Jarbidge Sage-grouse Planning Area, 2004

3.2.1.9 Mountain Home SGPA

3.2.1.9.1 Population

Lek data within the Mountain Home SGPA are too inconsistent to develop a trend graph. Only 2 leks were counted annually between 1966 and 1990.

3.2.1.9.2 Habitat

The sage-grouse habitat within the Mountain Home SGPA (Figure 3-12) is about 277,000 acres in size. The Bureau of Land Management administers 58% of the sage-grouse habitat within the area, 27% is private, 12% is state, and 3% is administered by USDA Forest Service. Seventy percent of the area is classified as key sage-grouse habitat, 10% is dominated by perennial grasslands, and 20% is annual grassland.

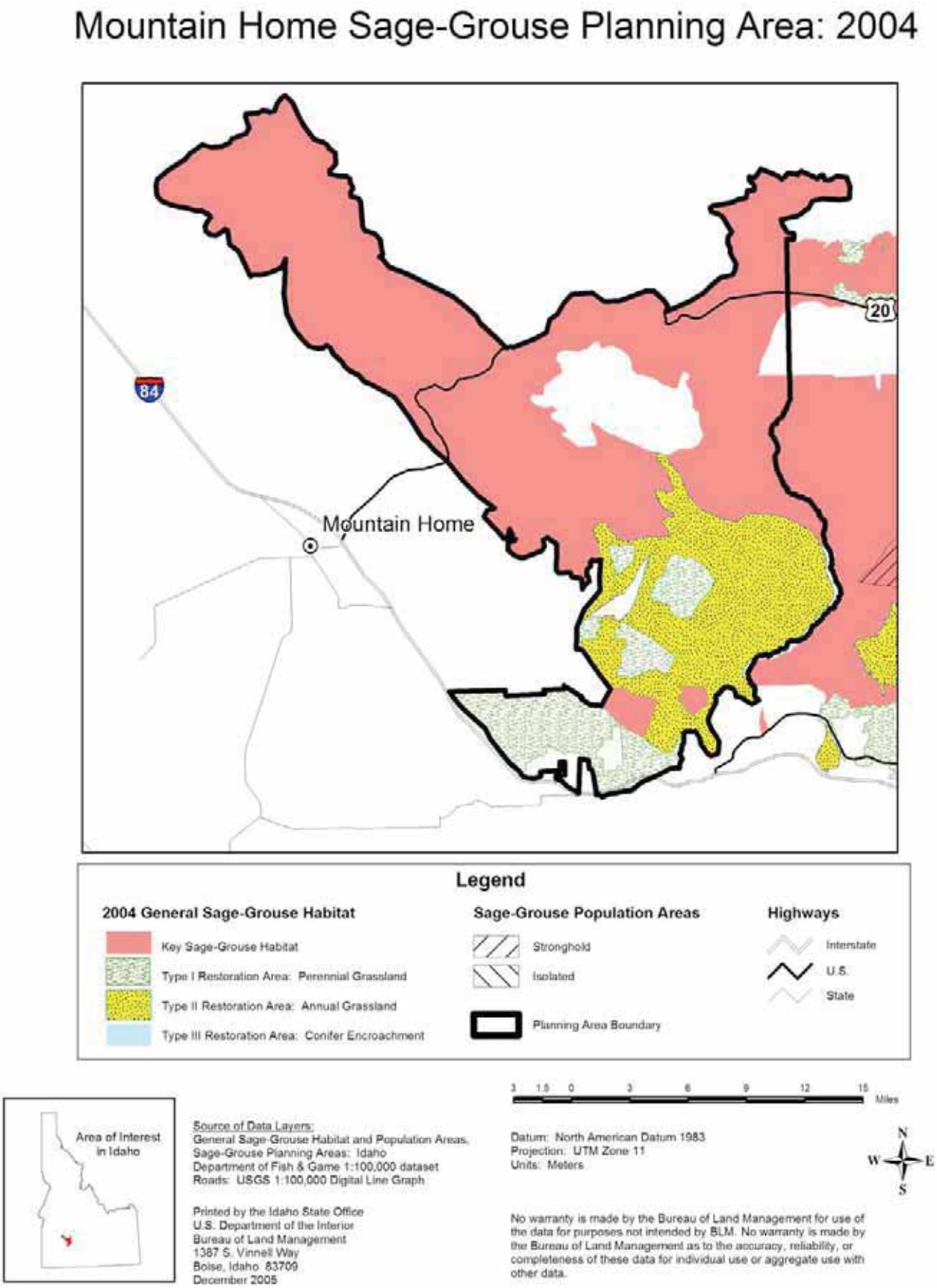

Figure 3-12 Map of Mountain Home Sage-grouse Planning Area, 2004

3.2.1.10 Owyhee SGPA

3.2.1.10.1 Population

Lek data within the Owyhee SGPA are too inconsistent to develop a trend graph. Numerous individual leks have been inconsistently counted between 1966 and 2005. More consistent counts along established lek routes did not begin until 1998.

3.2.1.10.2 Habitat

The sage-grouse habitat within the Owyhee SGPA (Figure 3-13) is about 2.6 million acres in size. The Bureau of Land Management administers about 83% of the sage-grouse habitat within the planning area, 10% is private, 7% is managed by the State. Seventy-three percent of the planning area is classified as key sage-grouse habitat, 11% is dominated by perennial grasslands, 5% is annual grasslands, and 11% is conifer encroachment. Further refinements of this map will be possible in the near future, as a result of mapping efforts underway via the Great Basin Restoration Initiative's Owyhee Uplands project.

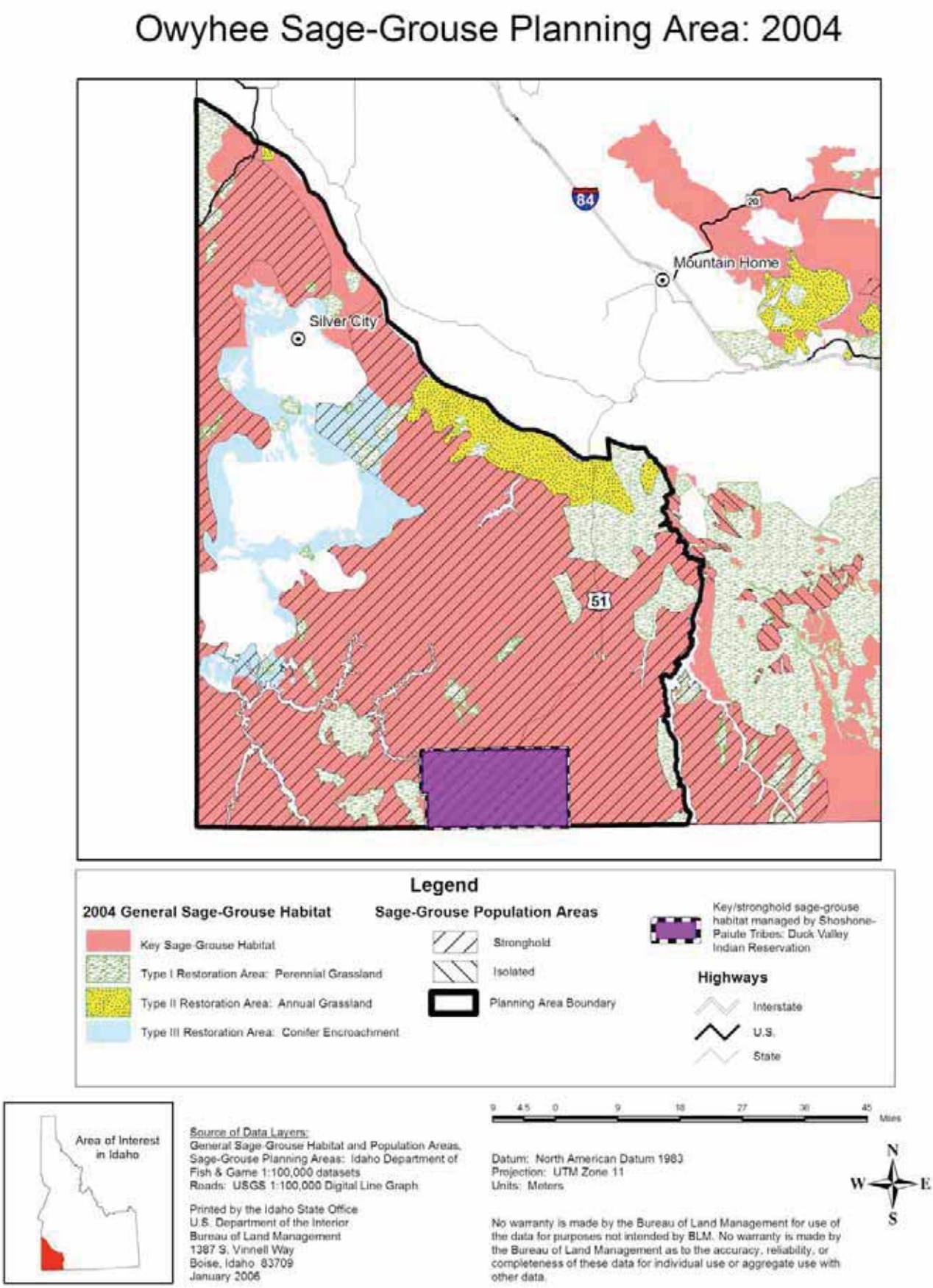

Figure 3-13 Map of Owyhee Sage-grouse Planning Area, 2004

3.2.1.11 Shoshone Basin SGPA

3.2.1.11.1 Population

Figure 3-14 shows the average number of males per lek counted (includes all leks counted with zeros) from 1986-2005. The data used to develop Figure 3-14 includes all lek counts along the Shoshone Basin lek route. Prior to 1986, only 2 leks along the established route were counted annually.

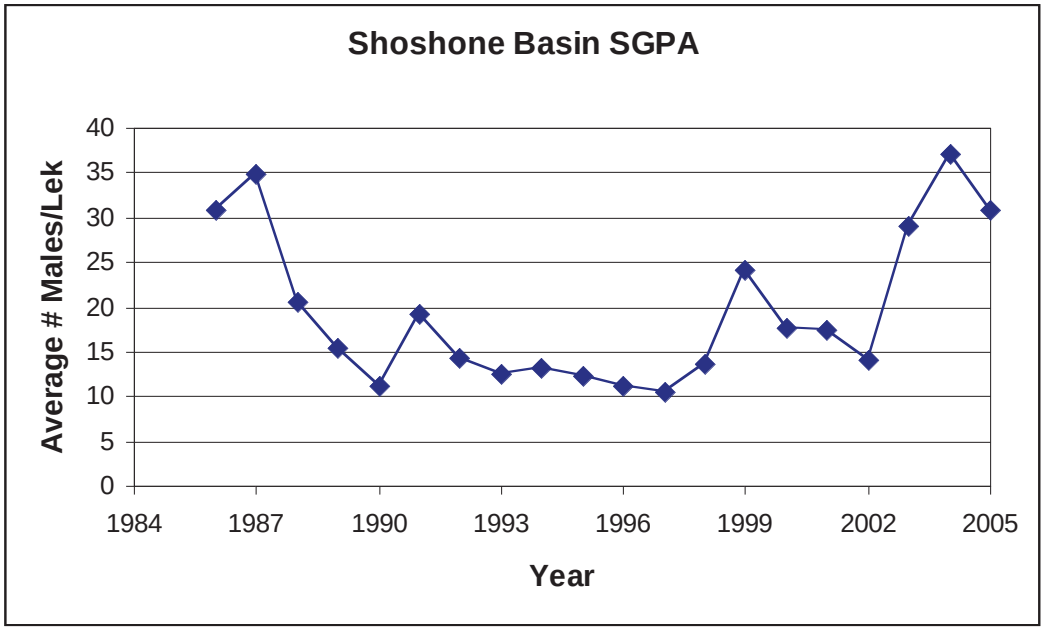

Figure 3-14 Changes in average number of males/lek 1986-2005, Shoshone Basin Sage-grouse Planning Area.

3.2.1.11.2 Habitat

The sage-grouse habitat within the Shoshone Basin SGPA (Figure 3-15) is about 180,000 acres in size. The Bureau of Land Management administers 51% of the sage-grouse habitat within the area, 45% is private, 4% is managed by the State, and <1% is USDA Forest Service. Eighty-seven percent of Shoshone Basin is classified as key sage-grouse habitat and 13% is dominated by perennial grasslands.

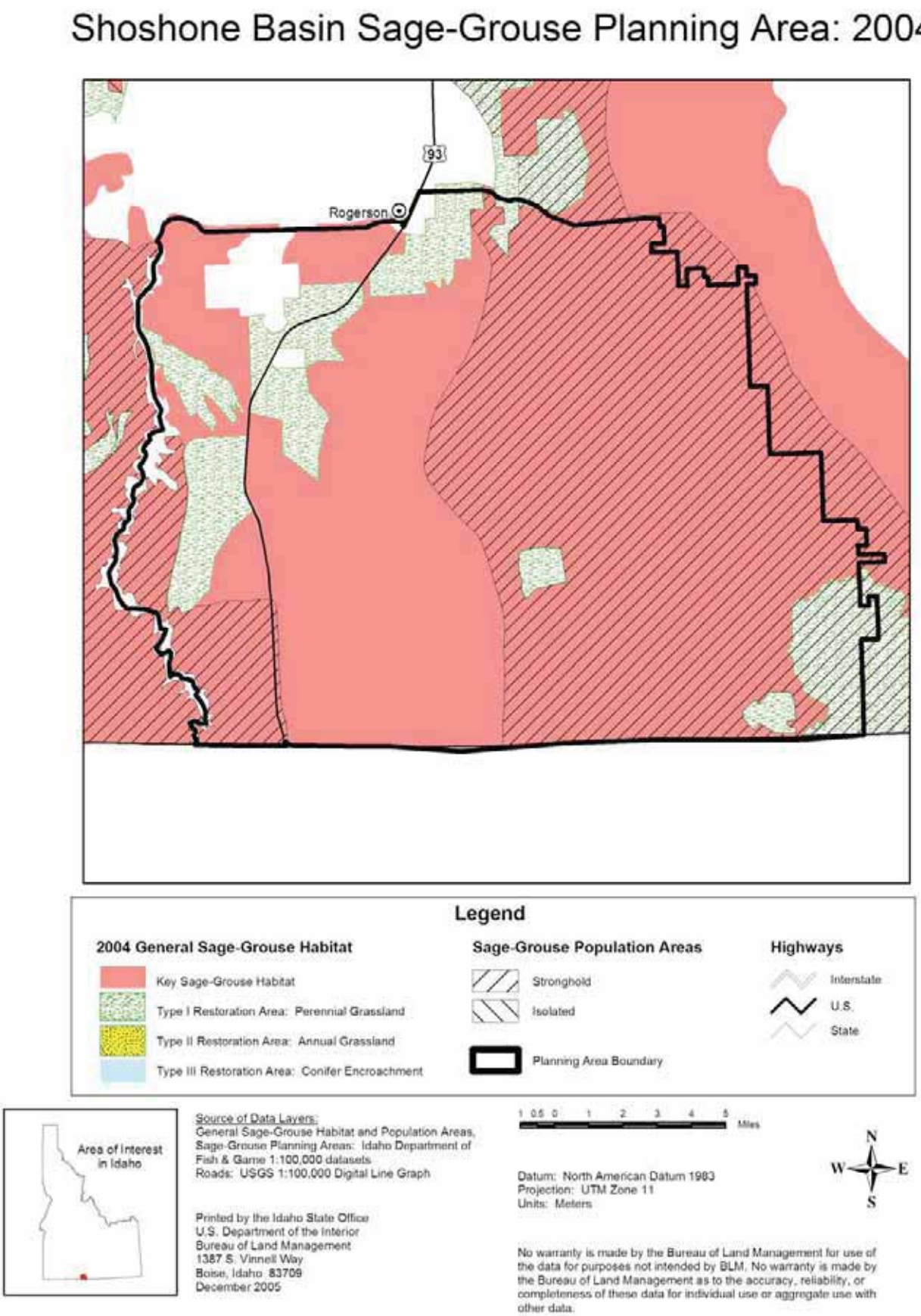

Figure 3-15 Map of Shoshone Basin Sage-grouse Planning Area, 2004

3.2.1.12 South Magic Valley SGPA

3.2.1.12.1 Population

Lek data within the South Magic Valley SGPA are too inconsistent to develop a trend graph. Numerous individual leks were counted between 1980 and 2005. One lek route was developed in the mid 1990s.

3.2.1.12.2 Habitat

The sage-grouse habitat within the South Magic Valley SGPA (Figure 3-16) is about 761,000 acres in size. The Bureau of Land Management administers 48% of the sage-grouse habitat within the area, 21% is private, 5% is managed by the State, and 26% is managed by USDA Forest Service. Less than 1% is managed by the National Park Service. Sixty-five percent of the area is classified as key sage-grouse habitat, 24% is dominated by perennial grasslands, and 11% is conifer encroachment.

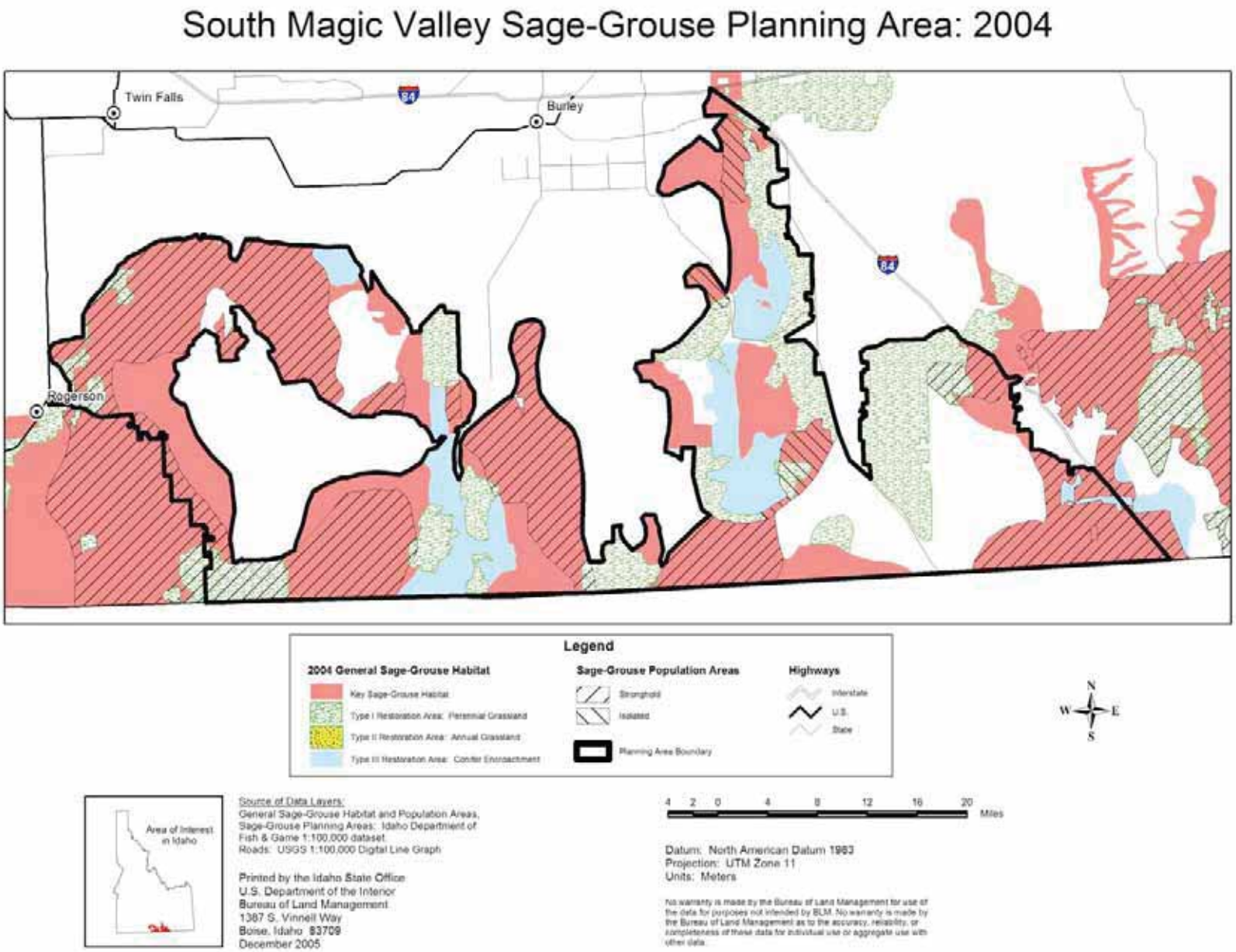

Figure 3-16 Map of South Magic Valley Sage-grouse Planning Area, 2004

3.2.1.13 Upper Snake SGPA

3.2.1.13.1 Population

Figure 3-17 shows the average number of males per lek counted, using data collected between 1953-2005. Some of the lek routes used in the analysis were not initiated until the late 1980s-1990s. Analysis is inclusive of all leks counted with zero males. Data used to develop Figure 3-17 includes lek counts from 13 lek routes (Red Road, Sheep Station, Market Lake, Jacoby, Plano, Stibal Road, Table Butte, Lidy, Medicine Lodge, Crooked Creek, Upper and Lower Birch Creek, and Little Lost).

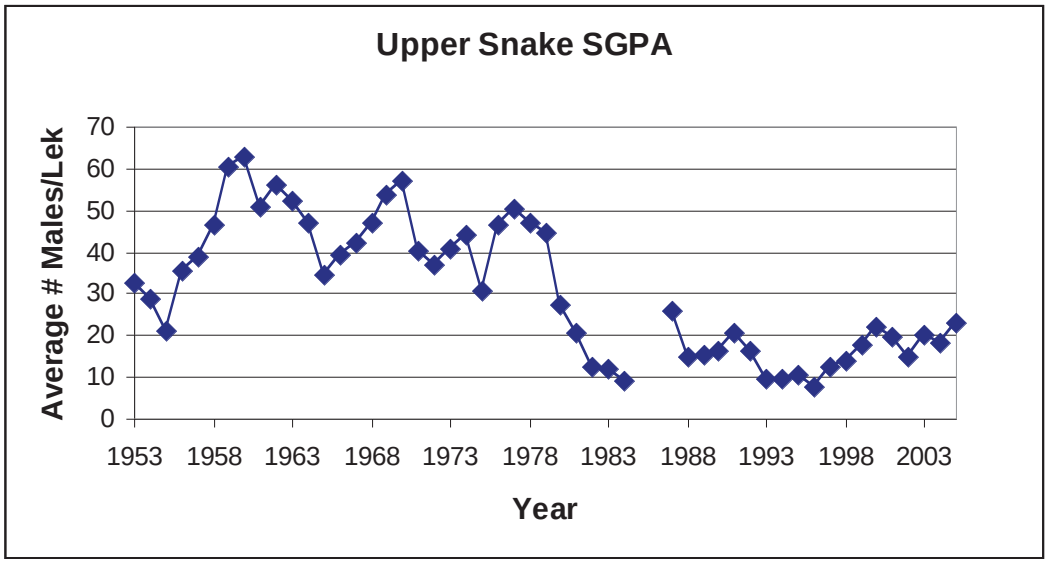

Figure 3-17 Changes in average number of males/lek 1953-2005 Upper Snake Sage-grouse Planning Area.

3.2.1.13.2 Habitat

The sage-grouse habitat within the Upper Snake SGPA (Figure 3-18) is about 2.5 million acres in size. The Bureau of Land Management administers 47% of the sage-grouse habitat within the area, Department of Energy administers 18%, 17% is private, 8% is managed by the State, 9% is administered by USDA Forest Service, and <1% is administered by U.S. Fish and Wildlife Service. Ninety percent of the area is classified as key sage-grouse habitat and 10% is dominated by perennial grassland. Conifer encroachment areas likely exist, but have not been incorporated into the Sage-Grouse Habitat Planning Map, as of 2004. On the

Upper Snake River Plain, 29,762 ha (73,512 acres) of sagebrush rangeland were converted to cropland between 1975 and 1992 (Leonard et al. 2000). This represents an 11% loss of sage-grouse key habitat within the study area (this does not represent the entire Snake River SGPA). It should be noted that the Challis and Upper Snake LWG Plans both address habitat in the Big Lost drainage, from Willow Creek Summit to Pass Creek.

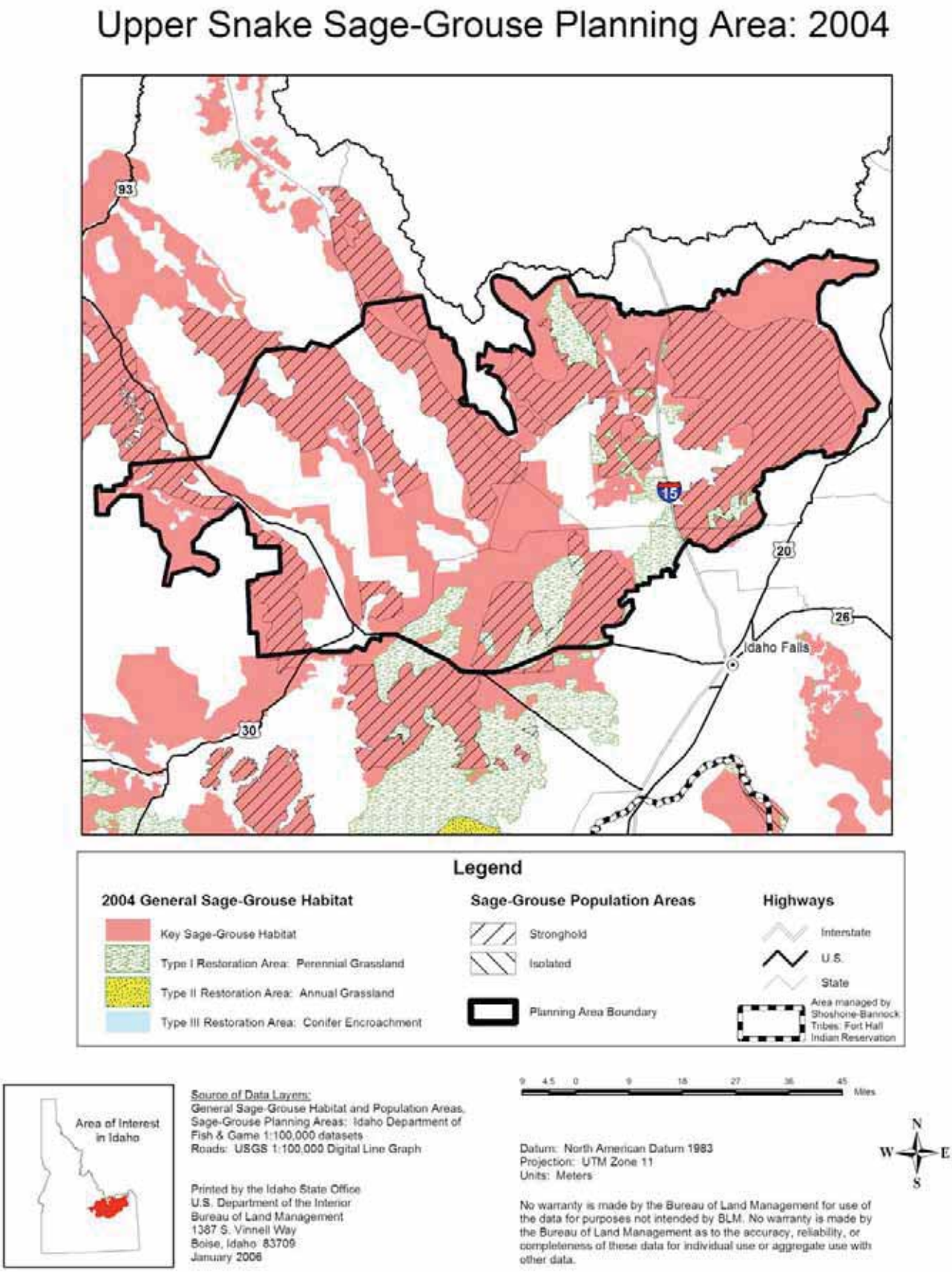

Figure 3-18 Map of Upper Snake Sage-grouse Planning Area

3.2.1.14 West Central SGPA

3.2.1.14.1 Population

Lek data within the West Central SGPA are too inconsistent to develop a trend graph. Four lek routes established in the mid 1990s have had consistent counts since 1996.

3.2.1.14.2 Habitat

The sage-grouse habitat within the West Central SGPA (Figure 3-19) is about 875,000 acres in size. The Bureau of Land Management administers 32% of the sage-grouse habitat within the area, 62% is private, 6% is managed by the State, and less than 1% is administered by USDA Forest Service. Thirty-one percent of the area is classified as key sage-grouse habitat, 25% is dominated by perennial grassland, and 44% is classified as annual grassland. Much of the perennial grassland is dominated by native grasses with islands of sagebrush. A change in the classification from perennial grassland to key habitat may be appropriate for some portions of the SGPA, contingent on the extent of sagebrush cover, distribution of sagebrush islands or other factors. Field-level ground truthing of these areas in the near future is warranted because much of the native perennial grassland type does not need to be rehabilitated. The annual grassland type will need to be monitored for presence/absence of sage-grouse as some of the area may be unsuitable for rehabilitation to sagebrush habitat due to topography and terrain.

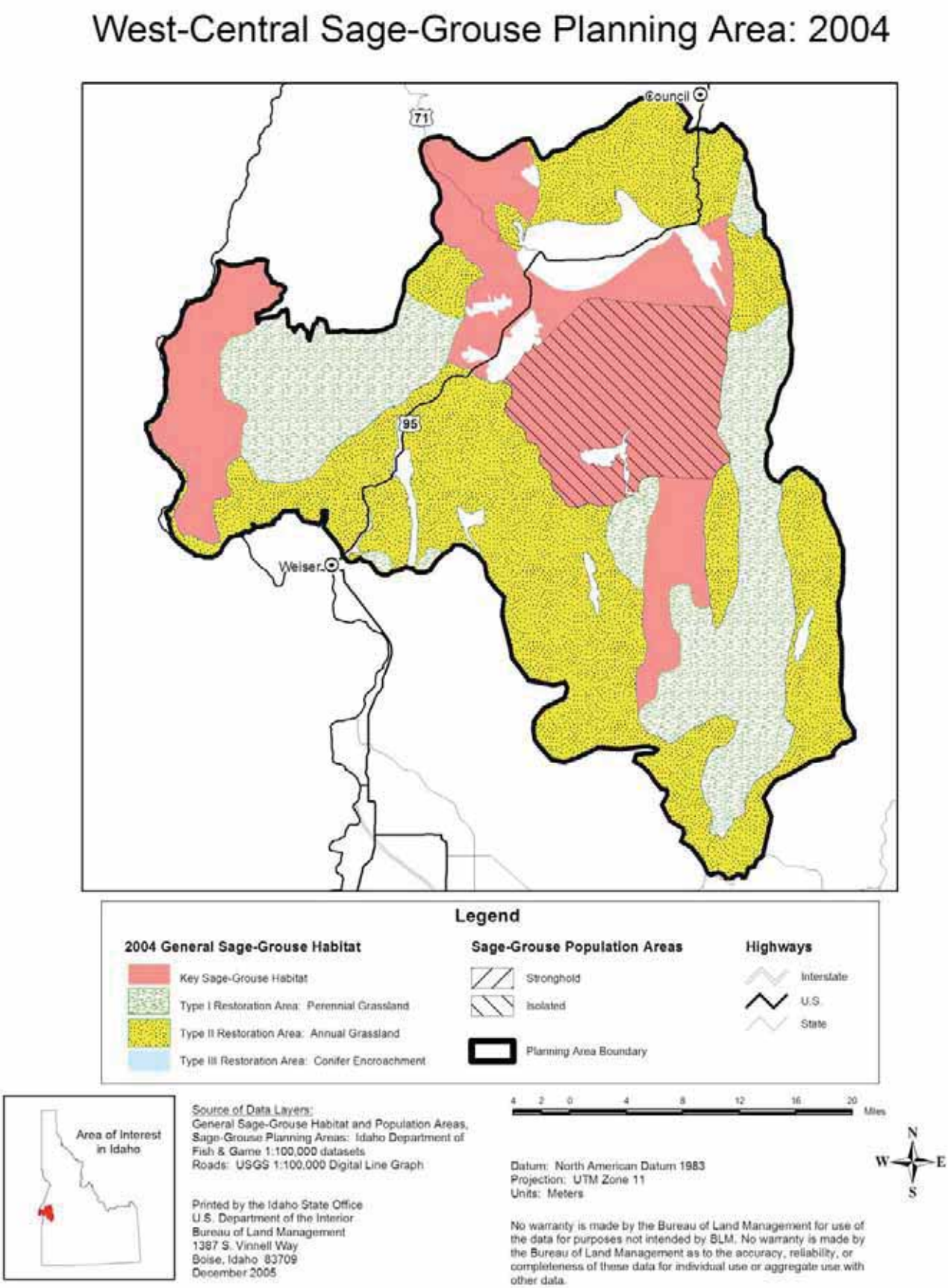

Figure 3-19 Map of West Central Sage-grouse Planning Area, 2004

3.2.1.15 West Magic Valley SGPA

3.2.1.15.1 Population

Figure 3-20 shows the average number of males per lek counted (includes all leks counted with zero males) from 1976-2004. Data used to develop Figure 3-20 includes lek counts from North Shoshone, Rock Creek, and Bliss/Hill City lek routes.

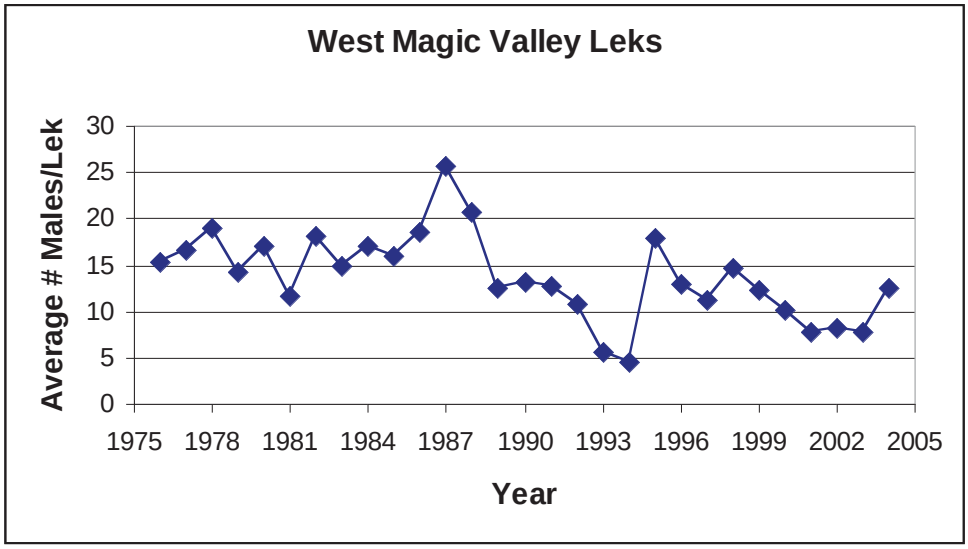

Figure 3-20 Changes in average number of males/lek 1976-2004, West Magic Valley Sage-grouse Planning Area.

3.2.1.15.2 Habitat

The sage-grouse habitat within the West Magic Valley SGPA (Figure 3-21) is about 731,000 acres in size. The Bureau of Land Management administers 78% of the sage-grouse habitat within the area, 15% is private, and 7% is managed by the State. Less than 1% is administered by USDA Forest Service. Fifty-six percent of the area is classified as key sage-grouse habitat, 38% is dominated by perennial grasslands, and 6% is annual grassland.

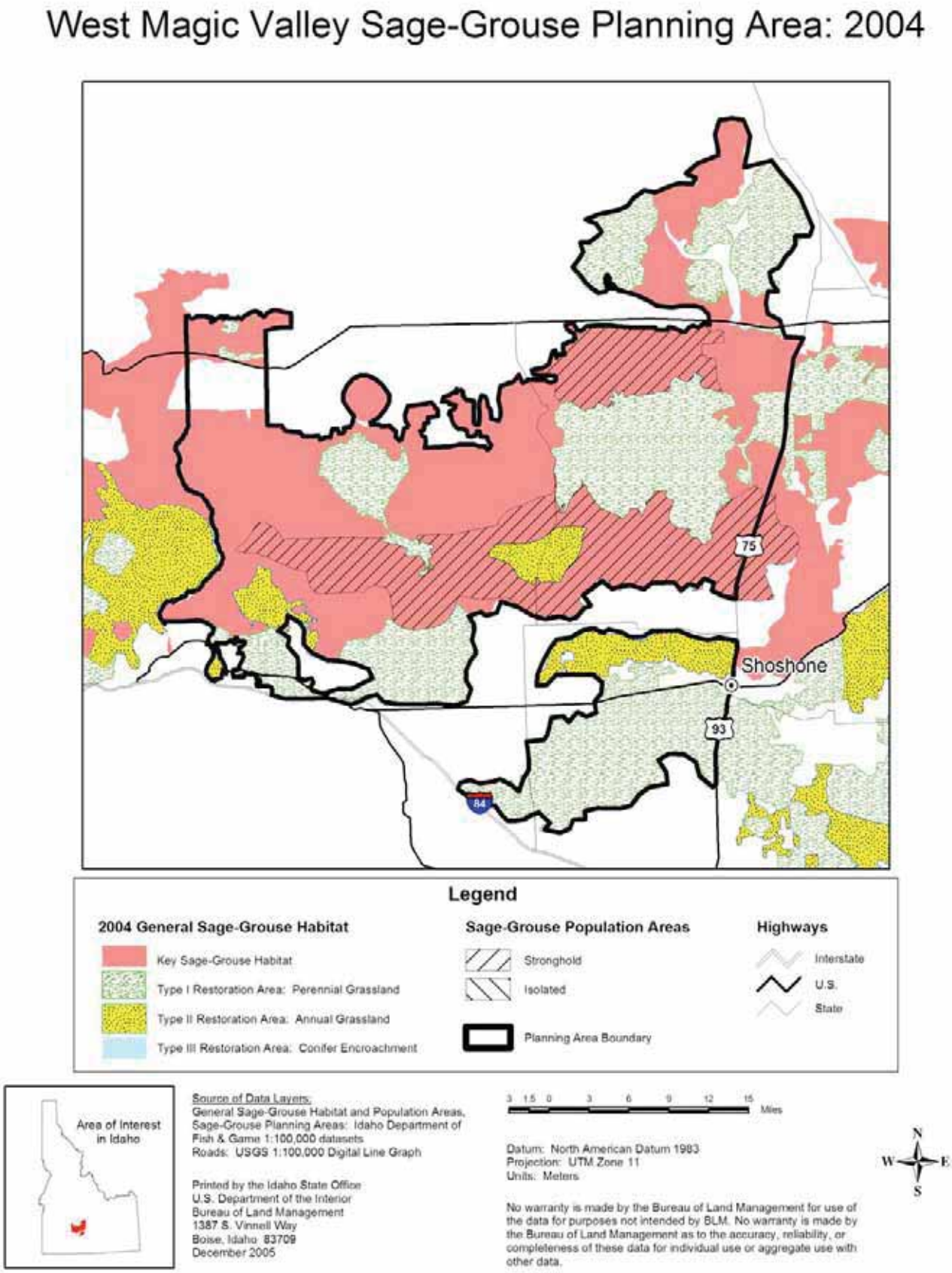

Figure 3-21 Map of West Magic Valley Sage-grouse Planning Area, 2004

Chapter 4 – Threats and Conservation Measures

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4 Threats and Conservation Measures

This chapter describes threats to sage-grouse and sage-grouse habitat, and provides recommended conservation measures to address those threats. The primary purpose of the information presented here is to assist Local Working Groups (LWGs) in the development or refinement of LWG sage-grouse conservation plans. Information in this chapter is presented in a hierarchical context starting at the rangewide scale, descending to the statewide scale, and then to the scale of the Sage-grouse Planning Areas (SGPA). This chapter includes background information, data, maps and selected hyperlinks as deemed appropriate. Much of this information is presented at the statewide scale. Where possible, threat data have been quantified at the SGPA scale. Over time, it is anticipated that LWGs and affiliated agencies will contribute finer resolution data that will be used in updating this information.

4.1 Rangewide threats overview

Detailed information on rangewide threats is presented in the *Conservation Assessment of Greater-Sage-grouse and Sagebrush Habitats* (Connelly et al. 2004). This assessment, along with information provided to the USFWS by other sources (e.g., state and federal agencies, non-governmental organizations, private individuals) was considered during the course of the status review and preparation of the Endangered and Threatened Wildlife and Plants: 12-Month Finding for Petitions to List the Greater Sage-grouse as Threatened or Endangered (USDI-FWS 2005, see Appendix C).

In the course of the status review, an expert panel identified the 19 most important threats to sage-grouse across its range, and assigned a relative rank to each threat within three geographical areas representing the eastern portion, western portion and entire range (USDI-FWS 2005). Overall, the panel determined that the highest ranking threats exerted their influence by habitat loss (USDI-FWS 2005).

Invasive species was ranked as the primary extinction risk factor for sage-grouse rangewide. In the western portion of the range, of which Idaho is a part, wildfire ranked second. In summary, the highest ranking rangewide threats, in order of rank, included: (1) invasive species, (2) infrastructure as related to energy development and urbanization, (3) wildfire, (4) agriculture, (5) grazing, (6) energy development, (7) urbanization, (8) strip/coal mining, (9) weather, and (10) pinyon-juniper expansion. Other threats such as disease and predation, hard-rock mining, hunting, and

contaminants were considered by the panel to be of lesser importance. Several panelists expressed concern about the synergistic aspects of threats, such as the connection between infrastructure increases and the expansion of invasive plant species (USDI-FWS 2005). The panel also predicted that the range of the greater-sage grouse would contract and fragment due to continued habitat modifications and loss (USDI-FWS 2005).

4.2 Statewide threats overview

On February 1-2, 2005, the Idaho sage-grouse science panel was convened in Boise to assist with identifying and ranking statewide threats and in estimating extirpation risk by geographic areas within Idaho. The panel consisted of six Idaho scientists (Dr. Steve Bunting, Professor, Department of Range Science, University of Idaho; Dr. Jack Connelly, Principal Wildlife Research Biologist, Idaho Department of Fish and Game; Dr. Steve Knick, U.S. Geological Survey/Biological Resources Division; Dr. Karen Launchbaugh, Chairperson, Department of Range Science, University of Idaho; Dr. Kerry Reese, Professor, Department of Fisheries and Wildlife, University of Idaho; and Dr. Mike Scott, Leader, Cooperative Fisheries and Wildlife Research Unit, University of Idaho) with acknowledged expertise in sage-grouse, rangeland, fire and landscape ecology. Appendix E provides additional details regarding the panel's composition, procedures, and findings. Results of the panel process are as follows:

Risk of extirpation of sage-grouse: Extirpation risk was evaluated for seven broad geographic areas of the state, each encompassing one or more SGPAs (see Science Panel Executive Summary, Appendix E). For consistency, the panel assumed that current management and trends/trajectories of threats, habitats and populations would continue. SGPAs with apparently higher extirpation risk (West Central, East Idaho Uplands, Curlew, East and West Magic Valley, Mountain Home) potentially have a more urgent need for conservation actions. However, proactive conservation planning and management actions in lower risk areas (Owyhee, Challis) are also important. For example, in these lower risk areas, the maintenance of ecosystem health and integrity should be priorities so that extirpation risk remains low.

Statewide threats to sage-grouse: The panel identified and ranked 19 threats to sage-grouse in Idaho (Figure 4-1). The statewide rankings are intended to serve as a tool for LWGs to consider as they identify and prioritize threats at the local SGPA level. It is important to note that the rankings reflect the collective, expert opinion of the panelists, based on a scoring process, and are not intended to imply unanimous agreement among the panelists. Because of the statewide focus, their rankings in many cases may not mirror threats or rankings at the finer scale SGPA/ LWG level.

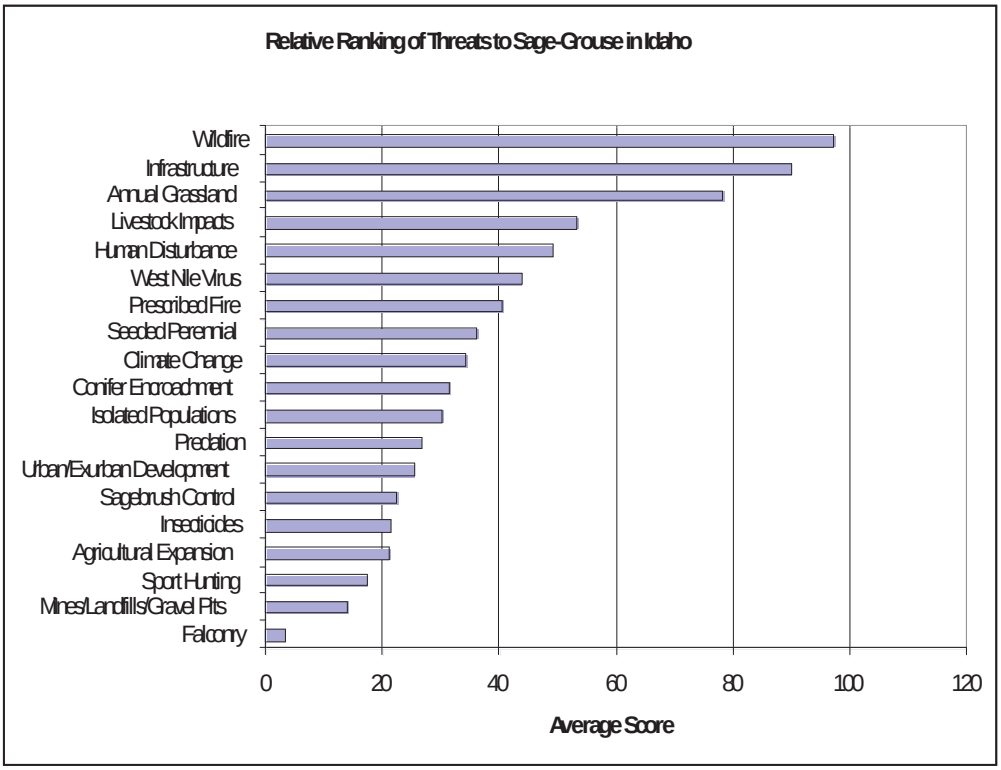


Figure 4-1 Summary ranking of threats to sage-grouse in Idaho (horizontal axis reflects an average of scores assigned by six Panelists)[1]

While Figure 4-1 places the array of threats in relative context with one another, there is also a great deal of inter-relatedness between many of the threats. That is, certain threats are closely linked to other related threats and therefore influence one another (e.g., annual grasslands and wildfire; human disturbance or urban development and infrastructure; climate change and annual grasslands/conifer encroachment). It is also important to recognize that while certain threats ranked relatively high or low in a statewide context, they may be ranked differently at the local level. The panel's findings are included to help shed light on various threats to sage-grouse statewide, however, the rankings are in no way intended to preclude or supersede the identification and prioritization of threats at the SGPA/ LWG level.

[1] Idaho Sage-Grouse Science Panel. February 1 and 2, 2005, Boise, Idaho.

4.3 Specific threats and related conservation measures

In the following pages, each of the 19 threats described by the Idaho sage-grouse science panel will be discussed and conservation measures presented. Depending on the particular threat, more or less supporting data and other information will be provided. In some cases, such as wildfire and infrastructure, a considerable effort was expended acquiring and analyzing available information. For other threats, such as mines/landfills/gravel pits, and sagebrush control, little data were readily available. Conservation measures are presented in the context of the particular threat they address, and are further grouped by issues specific to each threat.

In general, healthy rangelands provide a basic foundation for productive sage-grouse habitat. Rangeland health is defined as "*the degree to which the integrity of the soil and ecological processes of rangeland ecosystems are maintained*" (National Research Council 1994). Several of the described threats negatively affect sage-grouse as well as rangeland and their impacts may be cumulative. Rangeland health is addressed indirectly within the discussion of a number of the threats (e.g., infrastructure and human disturbance) and is addressed more directly in the threat discussion of annual grasslands and livestock impacts.

The recommended conservation measures presented in this chapter are designed to eliminate, reduce, or mitigate threats to sage-grouse or to ensure the long-term sustainability of sage-grouse habitat in Idaho. LWGs are encouraged to adopt these conservation measures or others that are more locally appropriate. These conservation measures should be implemented where feasible unless documented to be inappropriate at the site or project scale. Examples of such documentation could include: description of alternative conservation measures arising from site-specific analysis, monitoring, research, or adaptive management.

4.3.1 Wildfire

4.3.1.1 Threat summary and background

Crawford et al. (2004) suggested that the management of wildfire (and prescribed fire) "is considered one of the key issues in maintaining sage-grouse populations in sagebrush-dominated landscapes." In Idaho, wildfire poses a substantial threat to sage-grouse populations and habitat. Depending on weather, fuel conditions and other factors, wildfires potentially can quickly affect hundreds of thousands of acres of habitat in a single season. Consequently, proactive fire management and reduction of wildfire risk must continue to remain a priority.

4.3.1.2 Summary of key conservation issues

Several key issues are of primary concern. The establishment and proliferation of cheatgrass has resulted in altered fire regimes in some areas, resulting in more frequent fires and reduced habitat quantity and quality. Many wildfire ignitions are the result of a variety of human activities, and are largely preventable. Large wildfires have resulted in the reduction of significant acreages of sagebrush communities in some SGPAs, and have also hindered the recovery of sagebrush in older burns or rehabilitation areas. Finally, the rehabilitation of burned areas, while technically a management response to wildfire rather than an issue, is a crucial component of resource management on some southern Idaho rangelands, and therefore will be discussed separately.

Altered fuels and fire regimes: Historical fire-return intervals vary depending on the species and subspecies of sagebrush and site factors such as elevation and annual precipitation. See Chapter 2, Sagebrush Ecology section, for a more detailed discussion by sagebrush types. Fire regimes have changed across portions of the sagebrush biome (Connelly et al. 2004). Of particular concern in Idaho are lower elevation Wyoming big sagebrush sites, where wildfires have become much more frequent, due to the expansion of flammable, invasive annual grasses.

The proliferation of cheatgrass, an invasive annual grass species introduced in the late 1800s, has contributed to reduced fire-return intervals in parts of the Snake River Plain (Whisenant 1990). On many of these sites, fire-return intervals have been shortened to between two and four years (Whisenant 1990). Cheatgrass was reported as common on four million acres of Idaho rangelands as early as 1949 (Stewart and Hull 1949 cited in Pellant 1990). Cheatgrass and other problematic annuals such as medusahead rye (*Taeniatherum caput-medusae*) mature earlier than

native grass species, provide flammable, easily ignited fuels, and increase the likelihood of repeated fires (Young et al. 1987 cited in Pellant 1990). Many fires in south-central and western Idaho are fueled by the proliferation of the annual grasses described above.

Human-caused ignitions: Many Idaho wildfires are human-caused. Of 1,966 wildfires occurring from 1994 through 2003 on Idaho BLM lands, ignitions were determined to be 57% human-caused and 43% lightning-caused (USDI-BLM 2003). A more detailed analysis of point data from 1980 through 2003 revealed that in sage-grouse habitat on USFS and Department of Interior (BLM, BIA, USFWS, NPS) lands in Idaho, approximately 51% of ignitions were of natural origin (e.g., lightning) and the remainder were human-caused or unknown (Table 4-1).

Table 4-1 Summary of general ignition sources of fire on BLM, BIA, USFWS, NPS, and USFS lands in Idaho Sage-grouse Planning Areas, 1980-2003 (USDI-BLM 2004)

General ignition source	Percent (and number) of ignitions within key sage-grouse habitat and potential restoration habitat[2]		Percent (and number) of ignitions not within[3] key sage-grouse habitat or potential restoration habitat		Percent (and number) of all ignitions within SGPA perimeter	
Unknown	1	(46)	3	(25)	2	(71)
Natural e.g., lightning	51	(1,621)	48	(463)	50	(2,084)
Campfire	3	(87)	5	(44)	3	(131)
Smoking	1	(30)	3	(27)	1	(57)
Unauthorized burning[4]	10	(307)	16	(155)	11	(462)
Incendiary	4	(140)	3	(27)	4	(167)
Equipment	9	(297)	5	(51)	8	(348)
Railroads	5	(145)	5	(51)	5	(196)
Juveniles	1	(23)	2	(16)	1	(39)
Miscellaneous[5]	15	(478)	11	(103)	14	(581)
Total ignitions		**(3,174)**		**(962)**		**(4,136)**

[2] Potential restoration habitat includes perennial grassland, annual grassland, and conifer encroachment areas within Sage-Grouse Planning Areas, as delineated on the 2004 Idaho Sage-Grouse Habitat Planning Map.

[3] Defined as areas not classified as key sage-grouse habitat or potential restoration habitat within SGPAs, as delineated on the 2004 Idaho Sage-Grouse Habitat Planning Map.

[4] Wildfire ignitions that result from activities such as trash burning, burning dump, field burning, land clearing, slash burning, or right-of-way burning.

[5] Wildfire ignitions due to activities such as blasting, burning building, power line, or fireworks.

While lightning does play a substantial role in Idaho wildfire occurrences, there may be opportunity for reducing incidences of human-caused fires. Wildfire ignition sources by SGPA are shown in Table 4-2. Some SGPAs appear to be particularly troubling with respect to certain ignition sources, and many are likely preventable. For example, one-third of ignitions in the Challis SGPA and nearly one-quarter of ignitions in the East Idaho Uplands appear to have resulted from activities such as trash burning, field burning, land clearing and related practices. Railroad fires have been the source of ignitions in 14% of East Magic Valley wildfires. Use of equipment has apparently played an important role in Big Desert (12%), East Magic Valley (13%), Mountain Home (20%), and Shoshone Basin (16%) wildfire ignitions. A substantial proportion of wildfires in many SGPAs are of miscellaneous human origin. Accordingly, it may be appropriate to more aggressively target wildfire prevention, education, and enforcement efforts.

Table 4-2 Summary by Sage-grouse Planning Area of percent and number of general ignition sources within key and potential restoration habitat[6] on BLM, BIA, USFWS, NPS and USFS lands in Idaho, 1980-2003 (USDI-BLM 2004)

	Percent (and number) of wildfire ignitions by general source																				
SGPA	**Unknown**		**Natural (lightning)**		**Campfire**		**Smoking**		**Fire use[7]**		**Incendiary**		**Equipment**		**Railroads**		**Juveniles**		**Misc.[8]**		**Total ignitions**
Big Desert	**3**	(4)	**55**	(69)	**1**	(1)	**2**	(2)	**7**	(9)	**2**	(3)	**12**	(15)	**0**	(0)	**0**	(0)	**18**	(22)	(125)
Challis	**0**	(0)	**38**	(68)	**10**	(18)	**6**	(10)	**33**	(60)	**2**	(4)	**4**	(8)	**0**	(0)	**1**	(2)	**6**	(11)	(181)
Curlew	**1**	(2)	**74**	(122)	**1**	(2)	**0**	(0)	**5**	(9)	**4**	(7)	**5**	(8)	**0**	(0)	**0**	(0)	**9**	(14)	(164)
East Idaho Uplands	**1**	(1)	**45**	(42)	**1**	(1)	**1**	(1)	**23**	(21)	**5**	(5)	**6**	(6)	**0**	(0)	**2**	(2)	**15**	(14)	(93)
East Magic Valley	**1**	(6)	**39**	(198)	**1**	(6)	**1**	(4)	**10**	(50)	**5**	(27)	**13**	(68)	**14**	(73)	**0**	(2)	**15**	(77)	(511)
Jarbidge	**1**	(2)	**58**	(177)	**1**	(2)	**0**	(0)	**7**	(22)	**10**	(30)	**5**	(15)	**<1**	(1)	**<1**	(1)	**19**	(57)	(307)
Mountain Home	**0**	(0)	**49**	(52)	**3**	(3)	**0**	(0)	**7**	(8)	**4**	(4)	**20**	(21)	**1**	(1)	**1**	(1)	**16**	(17)	(107)
Owyhee	**2**	(6)	**57**	(140)	**<1**	(1)	**<1**	(1)	**7**	(17)	**2**	(6)	**7**	(17)	**1**	(2)	**<1**	(1)	**22**	(55)	(246)
Shoshone Basin	**0**	(0)	**49**	(24)	**2**	(1)	**2**	(1)	**6**	(3)	**0**	(0)	**16**	(8)	**0**	(0)	**0**	(0)	**24**	(12)	(49)
South Magic Valley	**3**	(12)	**72**	(320)	**1**	(6)	**<1**	(1)	**5**	(23)	**3**	(13)	**5**	(24)	**0**	(0)	**1**	(5)	**9**	(40)	(444)
Upper Snake	**1**	(5)	**46**	(154)	**5**	(18)	**2**	(7)	**10**	(35)	**3**	(9)	**10**	(32)	**6**	(19)	**1**	(2)	**16**	(55)	(336)
West Central	**2**	(4)	**62**	(137)	**6**	(13)	**1**	(2)	**2**	(4)	**2**	(5)	**7**	(16)	**4**	(9)	**<1**	(1)	**14**	(30)	(221)
West Magic Valley	**1**	(4)	**30**	(118)	**4**	(15)	**<1**	(1)	**12**	(46)	**7**	(27)	**15**	(59)	**10**	(40)	**2**	(6)	**19**	(74)	(390)
Total ignitions		**(46)**		**(1,621)**		**(87)**		**(30)**		**(307)**		**(140)**		**(297)**		**(145)**		**(23)**		**(478)**	**(3,174)**

[6] Inclusive of key sage-grouse habitat and potential restoration areas (perennial grassland, annual grassland, and conifer encroachment areas) as delineated on the 2004 Idaho Sage-Grouse Habitat Planning Map.

[7] Wildfire ignitions as a result of activities such as trash burning, burning dump, field burning, land clearing, slash burning, or right-of-way burning.

[8] Wildfire ignitions due to activities such as blasting, burning building, power line, or fireworks.

- **Reduction or modification of habitat:** Wildfires that have occurred since 1990 alone, have affected substantial acreages of sagebrush rangelands in Idaho, and pose a significant risk in some SGPAs. Spatial analysis of BLM and USFS wildfire occurrences in key habitat and potential restoration areas (perennial grasslands, annual grasslands, conifer encroachment areas) in Idaho indicate 2,155,088 "footprint acres" of wildfire between 1990 and 2003 (Table 4-3). The "footprint" concept serves to quantify actual on-the-ground habitat burned and set back to an earlier seral stage during the timeframe and does not include repeated burns of the same polygon(s). In terms of the proportion of sage-grouse habitat burned, wildfire appears to have played a relatively minor role in several SGPAs including the Challis, Owyhee, Shoshone Basin, Upper Snake, and West Central; however, fire has impacted substantial proportions of others, most notably the Big Desert, East and West Magic Valley, Jarbidge, and Curlew (Figure 4-2). In such areas, large, repeated fires provide little opportunity for sagebrush to recover to levels characteristic of breeding or winter habitat.

Table 4-3 Acres of wildfire by Sage-grouse Planning Area, 1990-2003 (USDI-BLM 2004)

SGPA	Footprint acres of sage-grouse habitat burned[9]	Percent of sage-grouse habitat burned[10]
Big Desert	536,531	63
Challis	6,703	<1
Curlew	81,886	21
East Idaho Uplands	46,429	9
East Magic Valley	446,853	35
Jarbidge	346,495	29
Mountain Home	50,621	18
Owyhee	107,494	4
Shoshone Basin	6,932	4
South Magic Valley	105,960	14
Upper Snake	191,668	8
West Central	48,206	6
West Magic Valley	179,310	25
Total	2,155,088	18

[9] Based only on wildfires within key sage-grouse habitat and potential restoration areas (perennial grassland, annual grassland, or conifer encroachment) as delineated on the 2004 Idaho Sage Grouse Habitat Planning Map (SGHPM). Not inclusive of fires in habitats unsuitable for sage-grouse (e.g., timber). Repeat-burns are not included.

[10] Percent of habitat (as defined in footnote 9) burned within the SGPA. Last row in table reflects total acres of wildfire and percent of key and potential restoration habitat burned, inclusive of all SGPAs.

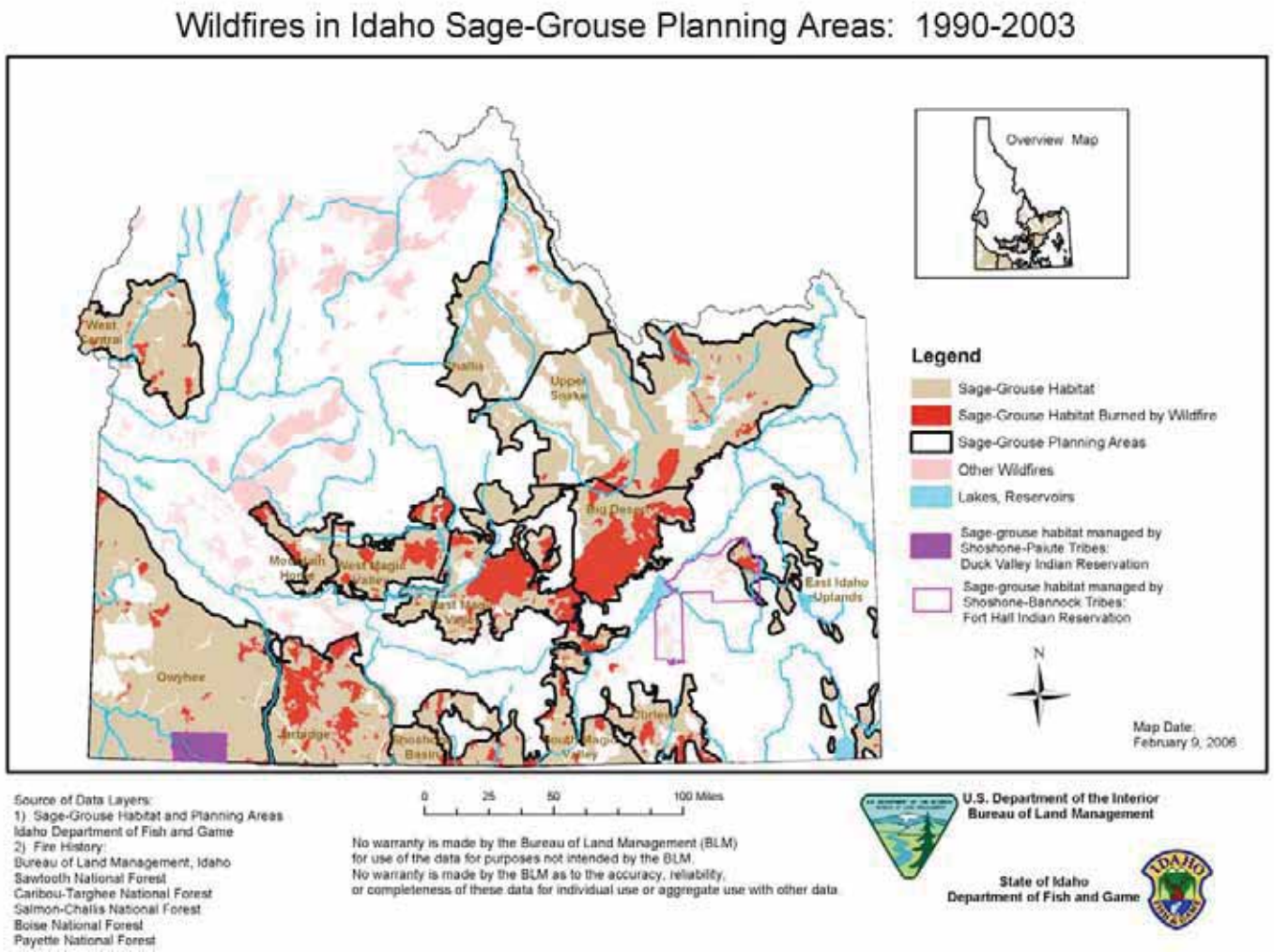


Figure 4-2 Fires burned in Idaho Sage- Grouse Planning Areas: 1990-2003[11]

[11] Red areas show cumulative burned areas within key sage-grouse habitat or potential restoration areas (described as annual grasslands, perennial grasslands and conifer encroachment areas), based on the 2004 Idaho Sage-Grouse Planning Map. Pink areas illustrate burns in areas that are not key habitat or potential restoration areas, or that are outside of Sage-Grouse Planning Areas.

An increased incidence of wildfire can pose a substantial threat to sage-grouse and sage-grouse habitat in Idaho in several ways. Frequent and/or large-scale wildfires (e.g., tens of thousands of acres or more) can remove substantial portions of remaining nesting, brood, or winter habitat in the course of hours or days, rendering vast areas unsuitable or marginal for sage-grouse for many years. Fire can also fragment existing habitats further by removing or reducing sagebrush cover or by impairing the progress of expensive sagebrush-steppe restoration efforts.

Studies of fire-effects on sage-grouse have been done in the context of both wildfires and prescribed fires. Some of these studies are referenced here in the wildfire section due to the similarity of the issues. Most fire-effects studies have been short-term involving a span of ten years or less (Crawford et al. 2004). The specific effects of fire on sage-grouse habitat vary and are driven by a number of factors including site potential; ecological condition; limiting functional plant groups; and the pattern, size, and season of burning (Crawford et al. 2004).

On the Hart Mountain National Antelope Refuge in Oregon, Byrne (2002) reported nest success in burns > 20 years old (29%, n=6/21 nests) was similar to nest success in unburned areas (28%, n=49/177 nests) but was zero in burns ≤ 20 years old (n=0/5 nests). Habitat characteristics around nests in burns > 20 years old were similar to those of unburned areas.

A nine-year study in Idaho suggested that late summer prescribed fire in Wyoming big sagebrush did not improve brood habitat (Connelly et al. 1994, Fischer et al. 1996*a*). Fischer et al. (1996*b*) noted that the abundance of *Hymenoptera* (e.g. ants) was significantly lower in burned habitats the second and third years after the burn. In a study of twenty wildfires and prescribed burns in Idaho, Nelle et al. (2000) reported that the relative abundance of ants and beetles, important sage-grouse chick foods, was significantly greater in the 1-year old burn category, but had returned to unburned levels by 3-5 years postburn; no difference was detected in forb abundance between different aged burns.

In another Idaho study, Pedersen et al. (2003) modeled the effects of sheep grazing and fire on sage-grouse populations. The study area included higher elevation (4,800-5,400 ft) breeding habitat characterized by mountain big sagebrush (with stands of threetip sagebrush also present) and winter habitat characterized by black sagebrush. With respect to fire alone, model simulations suggested that frequent (every 17 years) large wildfires (impacting 10% or more of the spring use habitat) are very detrimental to sage-grouse and could cause local extinctions.

In Oregon, frequency of ground-dwelling beetles was not influenced by prescribed fire; spring and fall burning increased total forb cover and diversity, but decreased sagebrush cover (Pyle and Crawford 1996). In mountain big sagebrush communities,

fire can enhance native perennial forbs and grasses where sagebrush is abundant if a healthy assemblage of native grasses and forbs is present and invasive plant species are limited (Crawford et al. 2004). Prescribed fire should not be used where sagebrush cover is a limiting factor for sage-grouse (Crawford et al. 2004). In general, caution should be exercised in the use of prescribed fire in sage-grouse habitats (Byrne 2002, Connelly et al. 2004, Crawford et al. 2004).

Spatial analysis of all wildfire occurrences, including repeat burns between 1990 and 2003, indicate a total of 2,436,936 acres of wildfire occurred in key or potential restoration habitat within the 13 SGPAs (Table 4-4). Of this total, 1,413,588 acres (58%) occurred in the adjacent Big Desert, East Magic Valley, and West Magic Valley SGPAs. An additional 370,577 acres of wildfire occurred in sage-grouse habitat within the Jarbidge SGPA. Although wildfire poses a potential risk to sage-grouse habitat in all SGPAs, it appears that this threat has been especially problematic in these SGPAs during the past fifteen years. Appropriate wildfire suppression, rehabilitation, restoration, and education efforts are warranted.

Table 4-4 Total wildfire acres in sage-grouse habitat[12] by Sage-grouse Planning Area, 1990-2003 (USDI-BLM 2004)

	Acres[13]															
SGPA	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**Misc.**	**Total**
Big Desert	-	6767	12599	-	250	7308	238690	2708	23063	179698	185780	1839	23	177	102	659004
Challis	-	-	-	-	-	-	-	-	-	-	-	-	-	6703	-	6703
Curlew	2533	9854	27252	-	12647	576	321	13	8605	1289	10384	8492	-	712	-	82678
E Idaho Uplands	1005	3130	25610	-	2350	1379	2565	-	-	4099	6118	-	89	2841	-	49186
E Magic Valley	12295	6704	176195	60	36460	30225	206232	335	2825	69871	5815	6810	9137	7459	-	570423
Jarbidge	2299	9891	16127	-	17627	112412	57964	6025	5873	26510	72323	19588	21569	2369	-	370577
Mt. Home	183	1216	24698	-	-	-	1009	1026	14	684	20657	1234	-	-	-	50721
Owyhee	12204	4534	1671	440	12523	2083	6675	87	156	22483	15611	15415	13808	211	-	107901
Shoshone Basin	-	-	-	-	135	-	732	-	-	183	5574	309	-	-	-	6933
S Magic Valley	12319	34	3430	-	4875	656	9659	197	338	7802	55306	2009	10266	497	-	107388
Upper Snake	-	3021	2438	47	29781	8497	21945	495	142	31541	39510	22	121	52927	2153	192640
West Central	1978	3328	15422	-	79	-	7045	277	3131	71	2812	2829	10217	1432	-	48621
W Magic Valley	73257	1190	28238	946	14	3592	36880	3408	2070	3785	9666	17911	68	3136	-	184161
Total	118073	49669	333680	1493	116741	166728	589717	14571	46217	348016	429556	76458	65298	78464	2255	2,436,936

[12] Sage-grouse habitat areas as delineated on the 2004 Idaho Sage-grouse Habitat Planning Map. Inclusive of areas areas defined as key sage-grouse habitat, and potential restoration areas (perennial grassland, annual grassland, and conifer encroachment areas).

[13] Table reflects total acres of wildfire in sage-grouse habitat as defined in footnote 12, above, including repeat fires. Figures are rounded to the nearest acre. "Misc." column reflects acres of fire that occurred sometime during 1999-2003, but the specific year was not available.

- **Restoration and burned area rehabilitation:** Connelly et al. (2004) discuss aspects of wildfire rehabilitation and restoration in considerable detail. Given the magnitude and frequency of wildfires and the potential for loss of sagebrush and expansion of invasive plants in southern Idaho, restoration activities and burned area rehabilitation will continue to play a critical role in sage-grouse conservation. Monsen et al. (2004) (see http://www.fs.fed.us/rm/pubs/rmrs_gtr136.html) provide a comprehensive and up-to-date source of information relative to the restoration of western rangelands. See also Lambert (2005) for descriptions, recommended seeding rates, and other useful information for nearly 250 species of native and non-native grasses, forbs and shrubs.

  BLM Public Land Statistics indicate that between 1997-2004, over $31 million was expended on Idaho Emergency Fire Rehabilitation and Stabilization projects alone, inclusive of revegetation, fencing, weed control, monitoring and related efforts. While burned area rehabilitation is essentially a reactive approach, occurring after wildfires, the protection, strategic planning, and restoration of areas *prior to* wildfire is also critical, and of even greater priority. Several important strategic processes have been recently initiated or completed to that end. These include:

  - BLM's Great Basin Restoration Initiative (GBRI), introduced in 1999, provides a strategy for prioritizing, protecting and restoring western landscapes. Several GBRI projects underway, that will improve our understanding and capability for rangeland restoration include: Great Basin Native Plant Selection and Increase Project; Coordinated Intermountain Restoration Project; Integrating Weed Control and Restoration for Great Basin Rangeland; and A Regional Experiment to Evaluate Effects of Fire and Fire Surrogate Treatments in the Sagebrush Biome.

  - Federal agencies (BLM, USFS) recently completed Fire Management Plan (FMP) revisions in accordance with National Fire Plan direction. Each plan contains suppression objectives to keep wildfires to a minimum size with consideration of sage-grouse habitat, including restoration areas. Specific suppression objectives have been established by the Fire Management Unit.[14] FMPs also identify areas for fire hazard reduction, which will reduce the duration of the fire season and enable suppression forces to more easily contain and minimize the size of fires.

  - Idaho BLM is preparing a "Fire, Fuels, and Related Vegetation Management Direction Plan Amendment," which will amend 12 Land Use Plans in Shoshone, Burley, Pocatello, and Idaho Falls. The final decision is scheduled for October 2006. The preferred alternative recognizes that the sagebrush steppe ecosystem and its associated wildlife species, including sage-grouse, are at risk from increased wildfire and other disturbances. The emphasis of this alternative is to

[14] Areas with similar resource objectives.

maintain existing high quality sagebrush steppe habitat and to increase the quantity of resilient sagebrush steppe through post-wildland fire rehabilitation and proactive restoration. Wildland fire efforts would emphasize protection of sagebrush steppe habitats.

- A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment (10-Year Comprehensive Strategy) was created under the National Fire Plan (August 2000) as a response to severe wildland fires and their impacts. The 10-Year Comprehensive Strategy lists four goals with goal three to Restore Fire-Adapted Ecosystems by rehabilitation, restoration, monitoring, using best available science and information. This includes preventing invasive species and restoring healthy, diverse and resilient ecological systems to minimize uncharacteristic severe wildfires.

4.3.1.3 Wildfire conservation measures

Goal: To reduce the risk, incidence and extent of wildfires within Sage-grouse Planning Areas, and to ensure that burned areas are rehabilitated, and historically altered sites are restored, where appropriate, in a manner consistent with long-term habitat needs for sage-grouse.

Issue Addressed	Rationale	Conservation Measure(s)
Altered fuels and fire regimes	Areas dominated by cheatgrass or medusahead have higher frequency of wildfire and minimal habitat value.	1. See conservation measures for Annual Grasslands section. 2. Identify and prioritize annual grasslands most conducive for restoration to perennial species. Coordinate closely with USGS Snake River Field Station, GBRI, Universities, local partners, and IDFG, as appropriate. 3. Since it is impossible to restore large annual grasslands all at once due to cost and logistics, consider an incremental or "buffer" approach, to protect existing in-tact habitat. That is, where large annual grasslands border key or other important areas such as recent restoration projects, create "buffers" by progressively converting broad bands of the adjacent annual grasslands to perennial species. As perennial grasses, forbs, and sagebrush become established, expand the buffers outward. This practice, over time, can reduce fire risk by conversion of high fire hazard annuals to lower hazard perennial fuels . Where funding and logistical factors permit, larger-scale conversions, rather than the buffer approach, may be more appropriate.

Issue Addressed	Rationale	Conservation Measure(s)
Reduction or modification of habitat	Wildfires can reduce or fragment already limited habitat, including recent restoration project areas, and can facilitate the proliferation of invasive plants.	**Wildfire suppression tactics:** 1. In the event that multiple ignitions occur in a local suppression unit area, suppression priorities are to protect human life and property. In situations where human safety or property will not be compromised or threatened, employ fire suppression tactics that protect sagebrush ecosystems by minimizing the average size of unplanned fires, maintaining productive sage-grouse habitat, and maintaining sagebrush cover. In the event of multiple fire starts in sagebrush ecosystems, suppression priority will be as outlined by specific Fire Management Unit (FMU) based on the following general guidelines: *Priority 1*- Stronghold habitats (subset of key habitat on the Idaho Sage Grouse Habitat Planning Map). a. Wyoming big sagebrush sites (in general, lower elevations). b. Mountain big sagebrush sites (in general, higher elevations). c. Other habitats (e.g. early sagebrush, low sagebrush sites). *Priority 2* - Key habitat. a. Wyoming big sagebrush sites (in general, lower elevations). b. Mountain big sagebrush sites (in general, higher elevations). c. Other habitats. *Priority 3* - Restoration habitat. a. Areas with established or recovering sagebrush. b. Areas with minimal or no sagebrush cover. *Priority 4* - Juniper or annual grasslands where delaying initial attack does not threaten priorities 1-3 above. 2. BLM and USFS line officers will ensure that a knowledgeable field level Resource Advisor is available for any "extended attack" fire (>300 acres in size) within or threatening sage-grouse habitats, including stronghold, key, and potential/existing restoration areas. Availability by phone or "on-call" is appropriate in some circumstances, such as during times of low fire danger. During times of high or extreme fire danger, red flag, or other similar conditions, resource advisors should be field-ready on short notice. 3. In all sage-grouse habitats (key, stronghold, potential

Issue Addressed	Rationale	Conservation Measure(s)
		restoration areas), suppress fires and hotspots in unburned areas including interior islands, patches, or strips of sagebrush if doing so will not compromise fire crew safety, poses little risk of escape, and to the extent that resources allow (limited water supplies, etc.). Do not square-up or burn-out islands or interior patches of sagebrush. Such areas may provide important remnant habitats post-fire, are useful in assessing pre-burn vegetation conditions, and serve as a source of on-site sagebrush seed, facilitating the post-fire reestablishment of sagebrush. 4. When fires threaten or occur within sage-grouse stronghold habitats, deploy the appropriate pre-identified appropriate management response as soon as possible to minimize loss of habitat to fire and to reduce the scale of subsequent ESR efforts. Depending on the nature of the fire, appropriate tools may include heavy or medium engines, dozers, hand crews, single engine aerial tankers, large tankers, or others. In general, the intent of this conservation measure is to encourage fire management officers, dispatch shift supervisors, and incident commanders to be proactive, to the extent feasible, in deploying suppression resources in order to minimize habitat loss. Fire crew safety will be the first priority. 5. Burn-out/backfiring operations should be conducted in a manner that minimizes the loss of sagebrush, while still providing for public and fire crew safety. 6. Use post-fire After Action Reviews and/or evaluations on fires that are large enough and/or intense enough to have adversely affected sage-grouse habitat. The intent of the review is to facilitate making improvements or adjustments in priorities, tactics or resource availability in preparation for potential fires. During multiple or sequential large-scale fire events this measure may need to be deferred. The urgency of the review depends on when the fire occurred in the fire season, how typical or significant it was, and if there are clearly opportunities to learn important lessons. **Strategic wildfire suppression planning:** 1. Ensure Fire Management Plans (FMPs), updated annually, re-assess priorities and incorporate the conservation measures outlined in this plan, particularly identifying the appropriate management response in Fire Management Units (FMUs) where stronghold and key habitat exist.

Issue Addressed	Rationale	Conservation Measure(s)
		2. In FMPs, annually update the Idaho Sage-grouse Habitat Planning Map (see Chapter 5). Update Fire Management Plans and Fire Management Unit databases as needed to incorporate new sage-grouse habitat related information and wildfire suppression priorities in sage-grouse or restoration habitats. 3. In areas of limited water availability and/or remote locations, coordinate with LWGs and appropriate agency personnel to explore creative options for the establishment of fill hydrants along existing pipelines, new emergency water storage tanks or other similar facilities, or upgrading/modification of existing wells or pipelines. Locate such water access facilities near suitable access roads. Mark locations of such sites on maps for fire crews, resource advisors, and dispatchers. Wildlife water guzzlers can also be designed in concert with such projects in sage-grouse habitats where water is limited. 4. Where feasible, consider staging initial attack resources in high fire incident areas to ensure quicker initial attack response times in remote areas. 5. At the wildland-urban interface bordering rangelands, employ pre-suppression tactics, public education and vegetation treatments to minimize or reduce the risk of the escape of human-caused fire into sage-grouse key or restoration habitat. 6. Strategically place pre-treated strips/areas (e.g., mowing, herbicide application, strictly managed grazed strips, etc.) to aid in controlling wildfire should wildfire occur near critical habitats. **Firefighter training:** 1. Provide annual training for rangeland fire personnel (including appropriate Rural Fire Department (RFD) personnel), public affairs staff, resource advisors, and others, as appropriate, to include awareness of issues and potential impacts of suppression activities in sage-grouse habitats and other resource issues of management concern.
Human-caused ignitions	Over half of wildfires in Idaho are human-caused.	**Public outreach and education:** 1. Increase public awareness of fire danger by installing and maintaining additional fire danger signs along main access roads.

Issue Addressed	Rationale	Conservation Measure(s)
		2. Increase public outreach, information, and education related to sagebrush ecosystems, fire risk mitigation, fire ecology and related issues. Examples include. media interviews and articles, presentations to schools and civic organizations, brochures or similar efforts. 3. Via media opportunities increase public awareness and understanding of fire-related risk during times of high to extreme fire danger and red flag conditions. 4. Work closely with railroad companies to minimize wildfire ignitions, improve suppression response, where needed, and to manage fuels/invasives within railroad rights-of-way. **Enforcement of restrictions or closures and related measures:** 1. Increase local enforcement of existing fire restrictions or closures in accordance with the High Fire Danger Closure and Restriction Plan. 2. Promote practices that discourage or limit firelines (e.g., dozer lines or other trails created by equipment) from being converted to 2-track roads or OHV/ATV trails.
Restoration and burned area rehabilitation	Analyze burned area to assess possibilities of natural regeneration. Deliberate seeding of some areas is essential to ensure that needed habitat components are restored.	1. Assess pre-burn vegetation via mapping, fuels/vegetation surveys or allotment monitoring records to determine plant species composition and diversity. Consider/evaluate fire severity. Acquire satellite or aerial imagery of the burn, where available and feasible, to help estimate the extent of burned and unburned areas, including islands. 2. In the absence of information for areas directly affected by the burn, evaluate unburned islands and the areas adjacent to the burn to help predict plant species composition and diversity within the burned area. 3. Estimate from the findings of 1 and 2 and a site potential analysis if rehabilitation is necessary to achieve the habitat goals for the area. 4. Ensure that sage-grouse habitat considerations are incorporated into restoration and burned area rehabilitation plans, particularly in or near stronghold, key and isolated habitats. 5. Emphasize the use of native plant materials to the greatest extent possible, and as appropriate for site

Issue Addressed	Rationale	Conservation Measure(s)
		conditions. Seeds should be certified weed free. 6. Use proper site-preparation techniques (e.g., seedbed preparation, control of invasives, weed-control), seeding techniques, and seed mixes in designing restoration and burned area rehabilitation plans. For example, the restoration of annual grasslands may require preparatory chemical treatments and/or an exotic/native seed mix. Perennial grasslands (existing seedings or native) may require seeding or planting of sagebrush. 7. When planting or reseeding sagebrush, favor the sagebrush species, subspecies, that are appropriate for the ecological site. Source identified seed is preferable. To maximize the likelihood of establishment, consider multiple approaches, such as aerial seeding, ground broadcast seeding with harrow or roller, and planting of seedlings in strategic patches or strips. Avoid seeding sagebrush or other shrubs near road margins if the road and road margin might otherwise serve as a fuel break in the event of future fires. 8. When using exotic perennial grasses and forbs in restoration use species whose growth form, species, and phenology, most closely mimic native species. 9. Provide for noxious weed control in burned area rehabilitation projects.

Research, monitoring or evaluation needs: Identify and prioritize specific areas for habitat restoration and fuels modification (e.g., cheatgrass). Identify and prioritize areas bordering roads, railroads, farmlands or other areas where cheatgrass or other vegetation poses a high fire risk. Research methods to improve the establishment and survival of sagebrush seeding efforts. Expand efforts to improve the commercial supply of native grasses and forbs suitable for Idaho rangelands.

4.3.2 Infrastructure

In the context of this Plan, the term infrastructure relates to human-made features on the landscape that provide or facilitate transportation, energy, and communications activities.

4.3.2.1 Threat summary and background

Infrastructure development, while essential for society, can nonetheless result in essentially irretrievable losses of sage-grouse habitat or fragmentation of habitat, foster the spread of invasives, facilitate predation, increase risk of mortality, increase human-disturbance or access, or influence behavior of sage-grouse. The significance of these threats is difficult to quantify and is likely to depend on site-specific influences. Six priority infrastructure features that currently affect or potentially affect sage-grouse and sage-grouse habitat in Idaho are addressed in greater detail below. Linear features include utility lines, roads, active railroads, and oil and gas pipelines. Nonlinear features of interest include wireless communications towers, and wind energy facilities. Additional factors not evaluated in this plan that may be of future concern to sage-grouse conservation in Idaho, depending on locality, include activities such as airport development or expansion; development of coal-fired power plants, geothermal or nuclear energy resources; or construction of similar facilities. As project proposals arise, LWGs and others concerned with sage-grouse conservation should actively engage in opportunities to provide comment and recommendations for avoiding or mitigating impacts to sage-grouse and other resource values.

4.3.2.2 Summary of key conservation issues

4.3.2.2.1 Linear infrastructure features

The following discussion of linear infrastructure features includes a summary of conservation issues associated with utility lines, roads, active railroads, and oil and gas pipelines. Where linear infrastructure features have been quantified in the discussions that follow, the term "buffer" refers to the area *potentially influenced* by the presence of these features on the landscape, based on assumptions of noise, predator foraging distances, and the likelihood of invasive plant establishment. The buffers used vary by infrastructure type, and are based on a similar buffer analysis presented in Connelly et al. (2004). While buffering provides a means to quantify these features, it must be recognized that actual impacts by the various infrastructure features on sage-grouse will likely vary from area to area depending on many different factors.

- **Utility lines:** Structures associated with utility corridors provide perches and nesting substrates for raptors and ravens (Knight and Kawashima 1993, Steenhof et al. 1993). Such structures may result in an increased concentration of raptors and ravens along utility corridors, which may pose a threat to sage-grouse by increasing their risk to avian predation in some areas. Sage-grouse may also avoid utility lines and other tall structures, though published data are limited. Corridors, access roads, and associated rights-of-way, may also facilitate the spread of invasive plant species (Gelbard and Belnap 2003) and facilitate the movement of predators (Connelly et al. 2004). Utility lines may also directly affect sage-grouse by posing a collision hazard (Braun 1998).

  While it was not possible to map and quantify all utility lines in Idaho at the scale of this plan, information for major power transmission lines (> 138 kv) was readily available. In Idaho, major power transmission lines within SGPAs total 1,503 miles. All SGPAs are affected by inclusion of major power transmission lines (USDI BLM 2004*c*; Table 4-5). Applying a 5 km (3.1 mile) buffer on each side to account for potential influences of avian predation (Connelly et al. 2004; S. Knick personal communication 2/9/2005), power line buffers incorporate approximately 4,526,893 acres, or 28% of all SGPAs combined. Some SGPAs are affected more than others. For example, while major power line buffers incorporate relatively small portions of the Curlew and Owyhee SGPAs, over 55% of the East Idaho Uplands, Mountain Home, West Central and West Magic Valley SGPAs are incorporated. Numerous smaller power distribution lines and telephone lines, not quantified or spatially portrayed here, also potentially influence sage-grouse and/or habitat, and may be of additional interest to LWGs.

  Opportunities exist for reducing or mitigating potential impacts. Best Management Practices are currently under development that will emphasize site-specific solutions (B. Dumas, Idaho Power Co., personal communication). In general, some impacts related to transmission lines can be reduced or minimized by managing roads, rehabilitating disturbed areas, controlling noxious weeds, and timing construction or maintenance activities to minimize disturbance.

Table 4-5 Idaho Sage-grouse Planning Areas and major power transmission lines (USDI BLM 2004)

POWER TRANSMISSION LINE 5 km BUFFER ANALYSIS					
SGPA Name	**Total acres within SGPA boundary**	**Length of transmission lines (meters) within SGPA**	**Transmission line mileage within SGPA**	**5km (6.2 mile) buffer[15] acres within SGPA**	**Percentage of SGPA covered by 5km buffer**
Big Desert Planning Area	884,715.33	84,089.08	52.25	234,972.35	27%
Challis Planning Area	1,826,860.33	189,349.82	117.66	341,561.96	19%
Curlew Planning Area	476,227.62	20,103.73	21.49	67,665.58	14%
East Idaho Uplands Planning Area	538,483.11	156,375.18	97.17	301,589.71	56%
East Magic Valley Planning Area	1,410,610.29	452,811.75	281.36	648,675.20	46%
Jarbidge Planning Area	1,250,139.39	75,172.38	46.71	217,389.16	17%
Mountain Home Planning Area	305,934.77	126,509.29	78.61	180,140.20	59%
Owyhee Planning Area	3,230,100.47	152,434.34	94.72	396,016.09	12%
Shoshone Basin Planning Area	187,380.44	73,387.31	45.60	87,300.74	47%
South Magic Valley Planning Area	898,358.79	96,337.10	59.86	219,593.29	24%
Upper Snake Planning Area	3,360,620.46	391,955.02	243.55	790,142.31	24%
West Central Planning Area	931,953.66	308,278.37	191.56	578,960.24	62%
West Magic Valley Planning Area	774,265.85	293,031.37	182.08	462,886.61	60%
TOTALS	**16,075,650.48**	**2,419,834.74**	**1,503.62**	**4,526,893.45**	**28%**

[15] Buffer of 5 km each side of transmission line as per by Connelly et al. (2004).

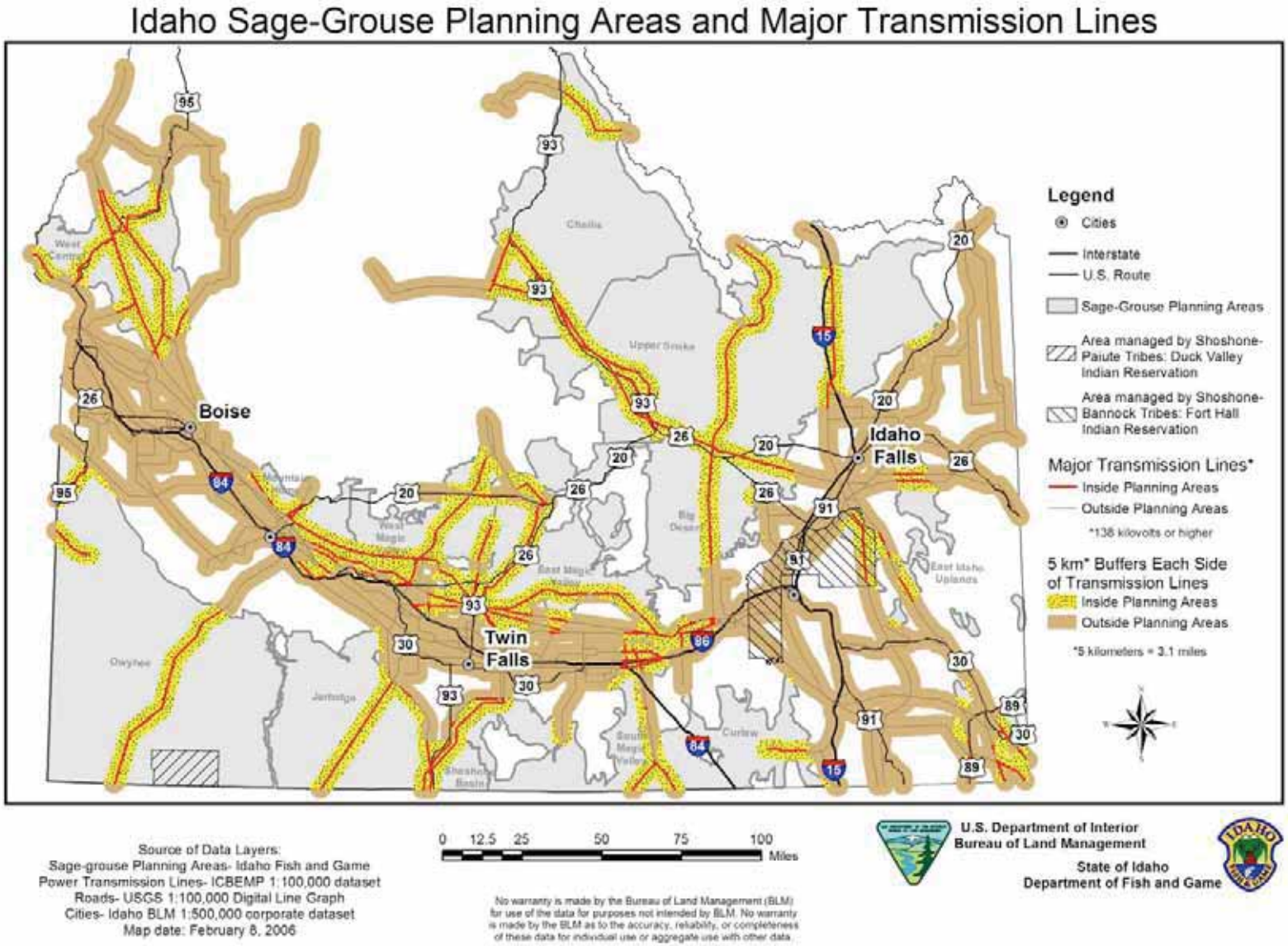


Figure 4-3 Idaho Sage-grouse Planning Areas and major transmission lines

- **Major paved roads:** It was not possible to quantify all improved and unimproved roads at the scale of this plan. However, major paved roads (State, U.S., and/or Interstate Highways) intersect most SGPAs in Idaho, with the exception of the Jarbidge (Table 4-6 and Figure 4-4). In general, traffic associated with major roads can lead to mortality of sage-grouse due to collisions. Habitat changes or noise associated with roads and traffic can modify animal behavior. Roads can also fragment landscapes, facilitate the spread of noxious weeds, and lead to increased use by humans. The incidence of human-caused fires is also closely related to the proximity of roads (Connelly et al. 2004). While roads pose a potential threat, they also can facilitate access for fire suppression activities, provide access for habitat and population monitoring, and for implementation of restoration projects.

  Spatial analysis of major roads (Figure 4-4) in Idaho indicate there are approximately 977.6 miles of major paved roads (Interstate, U.S., state) intersecting Idaho SGPAs (USDI-BLM 2004d). Applying a 10 km (6.2 mile) buffer along each side of these roads to account for an influence from predation and noise disturbance (Connelly et al. 2004), the total buffer area influenced by major paved roads within SGPAs is 6,890,485 acres. SGPAs with the greatest total major road mileage include the Challis, East Magic Valley, and Upper Snake. For eight SGPAs, Challis, Curlew, East Magic Valley, Mountain Home, Shoshone Basin, Upper Snake, West Central, West Magic Valley, >50% of the area is potentially influenced by major roads, based on the 10 km buffer concept. None of the Jarbidge SGPA appears influenced by major paved roads. While the degree of threat to sage-grouse in terms of road mileage or road density is presently uncertain, the documentation of existing conditions may be useful as a baseline for future analyses.

  While major paved roads are of primary interest, other roads (e.g., paved or graveled county roads, BLM, USFS, private, other) can also pose a risk to sage-grouse or sage-grouse habitat through factors such as increased human access, Off-Highway Vehicle (OHV) use, spread of invasive species, and increased wildfire risk and collisions. Vehicle-related mortalities of juvenile sage-grouse presumably foraging for milky forbs (e.g., *Tragopogon, Lactuca*) or other species along the Red Road, Jacoby Road, and the A2 Yale-Kilgore Road in the Upper Snake SGPA have been noted (M. Commons-Kemner, IDFG and R. Mickelsen USFS, personal communications). Some effort has been made by IDFG to reduce vehicular strikes along certain roads in the spring by mowing sagebrush nearby in an effort to encourage males to display off of the road itself (R. Mickelsen USFS personal communication).

Table 4-6 Idaho Sage-grouse Planning Areas and major roads [16] (USDI BLM 2004)

MAJOR ROADS 10 km BUFFER ANALYSIS					
SGPA Name	**Total Acres within SGPA boundary**	**Length of major roads (meters) within SGPA**	**Length of major roads (miles) within SGPA**	**Total Acres of buffered[17] major roads within SGPA**	**Percentage of SGPA covered by 10km buffer**
Big Desert Planning Area	884,715.33	57,350.87	35.64	289,897.35	32.77%
Challis Planning Area	1,826,860.33	291,023.46	180.83	1,114,792.15	61.02%
Curlew Planning Area	476,227.62	74,939.22	46.57	367,829.76	77.24%
East Idaho Uplands Planning Area	538,483.11	17,484.88	10.86	128,238.93	23.81%
East Magic Valley Planning Area	1,410,610.29	177,343.04	110.20	841,070.06	59.62%
Jarbidge Planning Area	1,250,139.39	0.00	0.00	28,262.53	2.26%
Mountain Home Planning Area	305,934.77	37,046.81	23.02	182,483.13	59.65%
Owyhee Planning Area	3,230,100.47	127,989.14	79.53	680,616.32	21.07%
Shoshone Basin Planning Area	187,380.44	29,096.02	18.08	108,809.65	58.07%
South Magic Valley Planning Area	898,358.79	56,142.47	34.89	426,392.28	47.46%
Upper Snake Planning Area	3,360,620.46	462,974.06	287.68	1,752,052.78	52.13%
West Central Planning Area	931,953.66	104,482.95	64.92	394,815.77	42.36%
West Magic Valley Planning Area	774,265.85	137,424.93	85.39	575,224.53	74.29%
Total	**16,075,650.48**	**1,573,297.85**	**977.60**	**6,890,485.25**	**42.86%**

[16] Based on USGS 1:100,000 Digital Line Graph.

[17] Buffer of 10 km each side of road, as per Connelly et al. (2004). Jarbidge SGPA shows buffer acreage despite 0.0 miles of major roads due to overlap of buffers from roads outside but near the SGPA boundary.

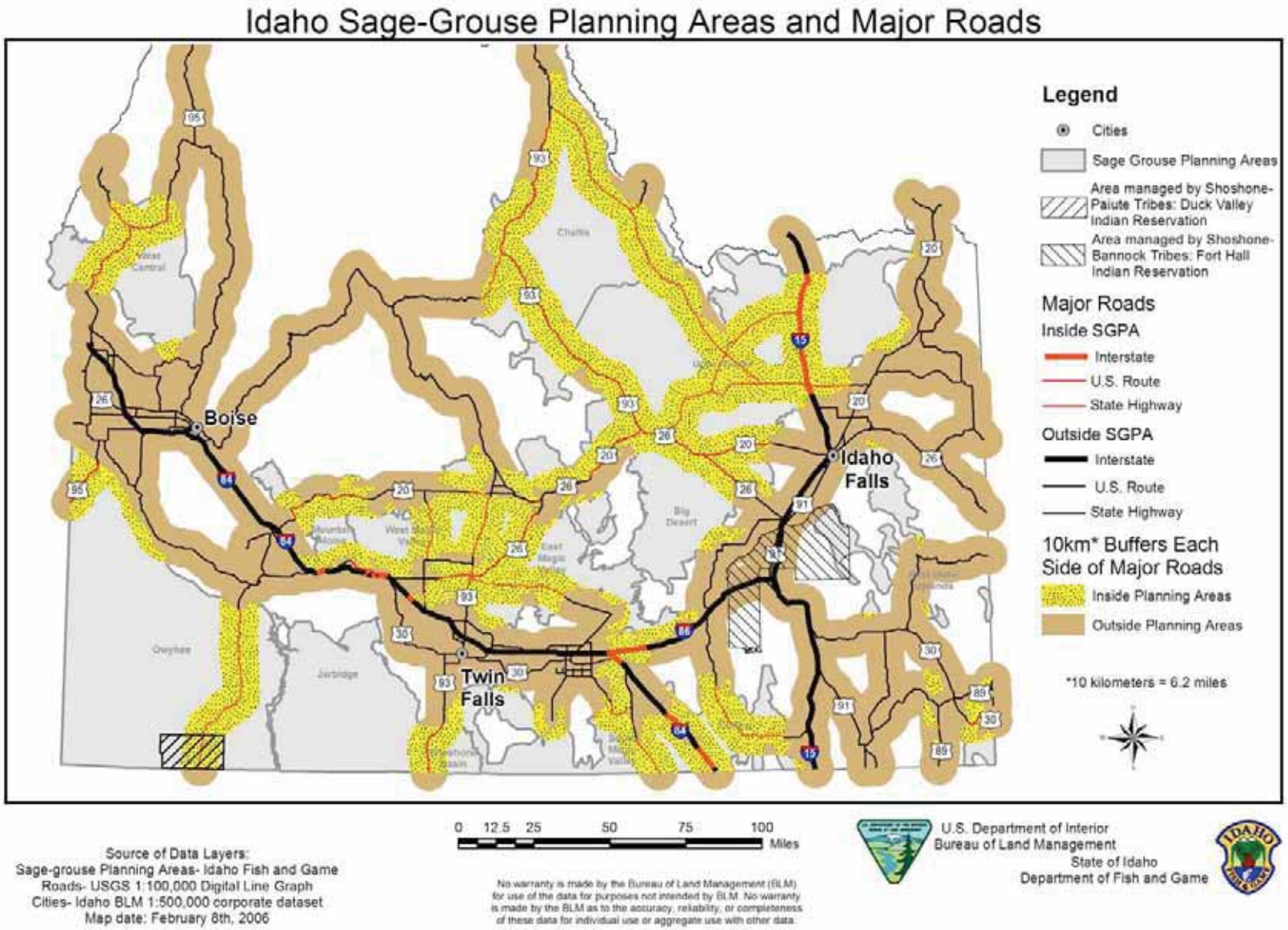


Figure 4-4 Idaho Sage-grouse Planning Areas and major roads

- **Active Railroads**: Railways are largely attributed with the initial spread of cheatgrass in the intermountain region (Young and Sparks 2002 cited in Connelly et al. 2004). Wildfires sparked by trains can lead to loss of sagebrush habitats and promote the further spread of cheatgrass. Active railroads intersect portions of seven of the 13 SGPAs in Idaho (Table 4-7 and Figure 4-5). While this threat factor collectively impacts a relatively small proportion of SGPAs in terms of mileage and buffer acreage, impacts can be important locally. For example, from 1980-2003, railroads accounted for 14% and 10% of wildfire ignitions in the East and West Magic Valley SGPAs, respectively (USDI BLM 2004*e*). Rapid fire suppression and provision for perennial species along railroad corridors are important factors in managing this threat.

Table 4-7 Idaho Sage-grouse Planning Areas and active railroads[18] (USDI BLM 2004*e*)

RAILROAD 3 KM BUFFER ANALYSIS					
SGPA Name	**Total acres within SGPA boundary**	**Length of active railroads (meters) within SGPA**	**Active railroad mileage within SGPA**	**3 km (1.86 mile) buffer[19] acres within SGPA**	**Percentage of SGPA covered by 3 km buffer**
Big Desert Planning Area	884,715.33	60,839.83	37.80	84,122.99	10%
Challis Planning Area	1,826,860.33	0.00	0.00	0.00	0%
Curlew Planning Area	476,227.62	0.00	0.00	168.17	0%
East Idaho Uplands Planning Area	538,483.11	10,027.12	6.23	28,595.43	5%
East Magic Valley Planning Area	1,410,610.29	122,369.43	76.04	157,847.43	11%
Jarbidge Planning Area	1,250,139.39	0.00	0.00	0.00	0%
Mountain Home Planning Area	305,934.77	4,444.45	2.76	8,515.27	3%
Owyhee Planning Area	3,230,100.47	0.00	0.00	0.00	0%
Shoshone Planning Area	187,380.44	0.00	0.00	0.00	0%
South Magic Valley Planning Area	898,358.79	0.00	0.00	0.00	0%
Upper Snake Planning Area	3,360,620.46	100,436.98	62.41	163,198.69	5%
West Central Planning Area	931,953.66	20,414.05	12.68	20,227.78	2%
West Magic Valley Planning Area	774,265.85	44,177.05	27.45	69,732.60	9%
Total	**16,075,650.48**	**165,028.07**	**225.38**	**532,408.36**	

[18] Based on US Census Bureau data 1:100,000

[19] Buffer of 3 km each side of railroad, as per Connelly et al. (2004), to account for potential for invasive species.

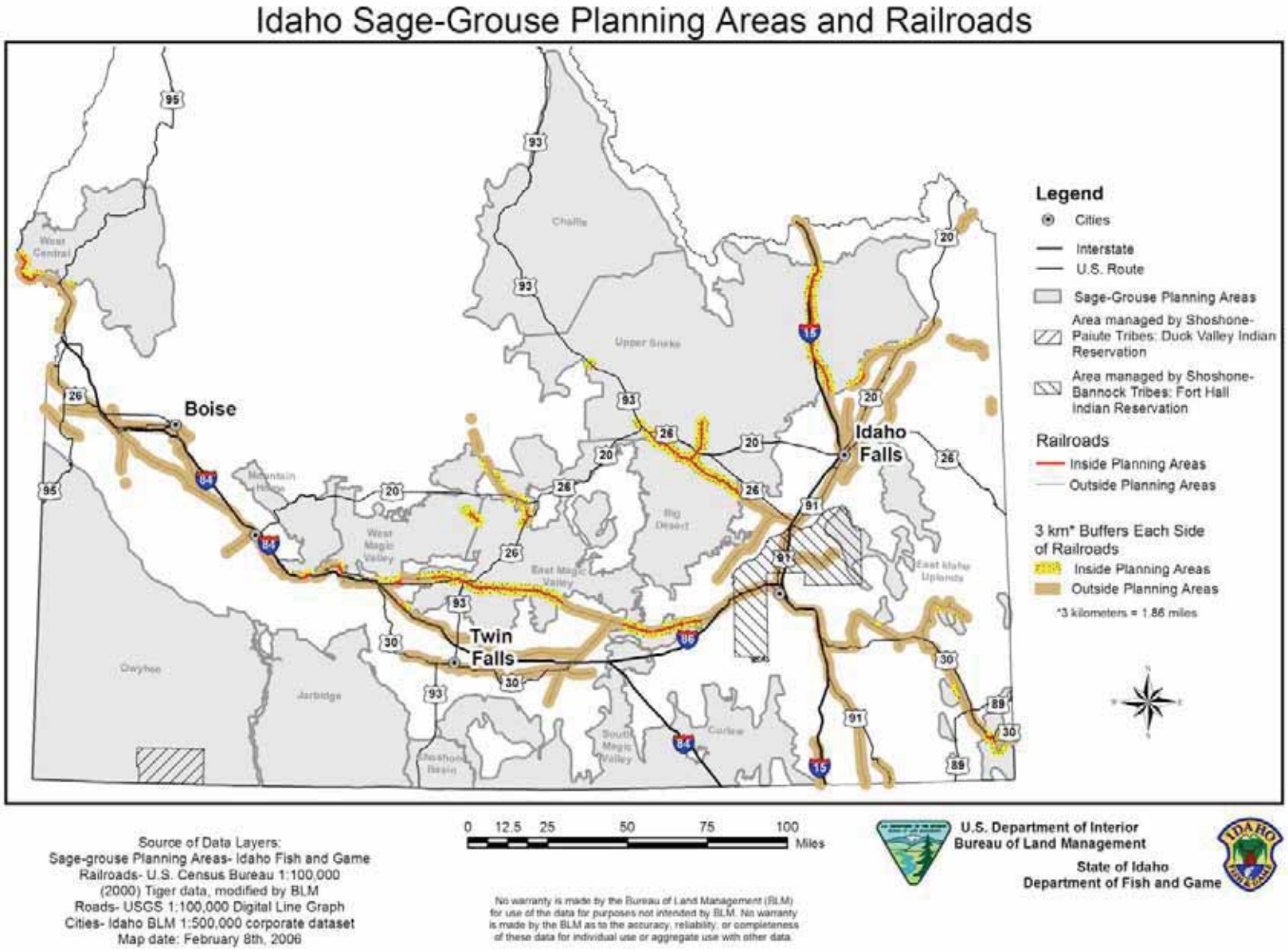


Figure 4-5 Idaho SGPAs and active railroads

- **Oil/gas pipelines:** Pipelines intersect minor portions of seven SGPAs (Table 4-8 and Figure 4-6). Surface disturbances and roads associated with pipelines pose a potential threat to sage-grouse or sage-grouse habitat, as they can facilitate predator movements, foster invasion by weedy plant species, and fragment habitat locally. The re-vegetation of lands disturbed by pipeline construction activities using the appropriate perennial species is crucial to minimize the likelihood of establishment by invasive plants. Periodic weed control is also warranted. Pipeline construction and maintenance activities in proximity to important seasonal habitats may disturb sage-grouse, particularly in the vicinity of leks. Managing the timing of such activities can help to reduce or eliminate disturbances.

Table 4-8 Idaho Sage-grouse Planning Areas and oil/gas pipelines[20] (USDI BLM 2004)

PIPELINE 1 KM BUFFER ANALYSIS					
SGPA NAME	**Total acres within SGPA boundary**	**Length of Pipeline (meters) within SGPA**	**Pipeline Mileage within SGPA**	**1 KM buffer[21] acres**	**Percentage of SGPA Covered by 1 km buffer**
Big Desert Planning Area	884715.33	0.00	0.00	0.00	0%
Challis Planning Area	1826860.33	0.00	0.00	0.00	0%
Curlew Planning Area	476227.62	6,422.98	3.99	4,918.70	1%
East Idaho Uplands Planning Area	538483.11	19,114.70	11.88	9,057.03	2%
East Magic Valley Planning Area	1410610.29	26,476.05	16.45	13,631.50	1%
Jarbidge Planning Area	1250139.39	0.00	0.00	0.00	0%
Mountain Home Planning Area	305934.77	27,584.55	17.14	8,716.65	3%
Owyhee Planning Area	3230100.47	103,157.36	64.10	51,163.33	2%
Shoshone Basin Planning Area	187380.44	0.00	0.00	0.00	0%
South Magic Valley Planning Area	898358.79	40,210.23	24.99	16,984.27	2%
Upper Snake Planning Area	3360620.46	0.00	0.00	0.00	0%
West Central Planning Area	931953.66	0.00	0.00	7.25	0%
West Magic Valley Planning Area	774265.85	20,772.38	12.91	10,189.35	1%
Total	**16,075,650.48**	**243,738.25**	**151.45**	**114,668.10**	

[20] Based on Idaho BLM 1:24,000 Corporate dataset

[21] Buffer of 1 km each side of pipeline as per Connelly et al. (2004) to account for potential influences of predation, invasives, noise

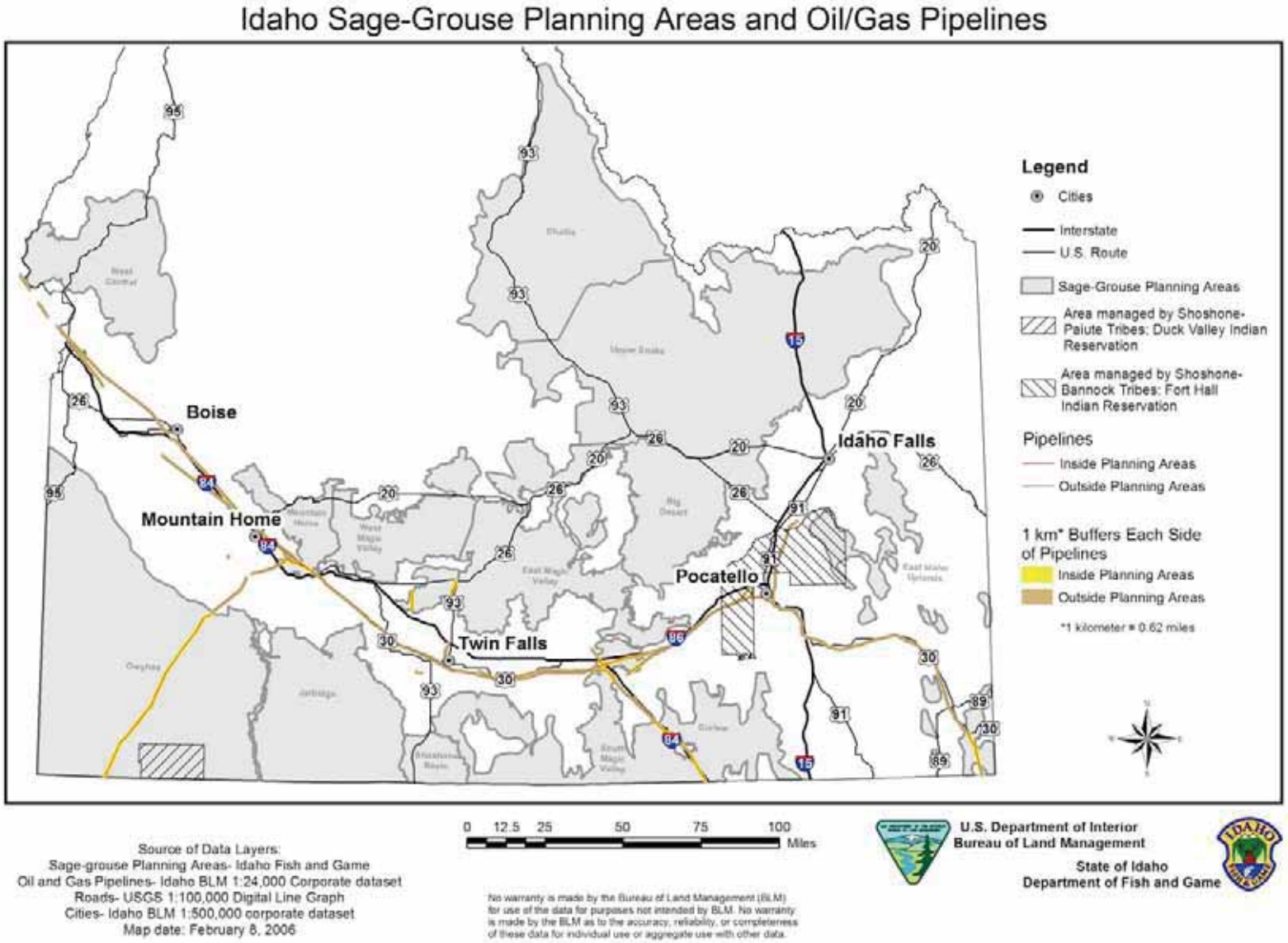


Figure 4-6 Idaho Sage-grouse Planning Areas and oil/gas pipelines

4.3.2.2.2 Cumulative effects and density of linear infrastructure features

While buffers of certain linear infrastructure features such as oil/gas pipelines and active railroads encompass relatively small portions of SGPAs, an analysis of merged buffers of all four linear features (where buffers for major roads, major power lines, active railroads and oil/gas pipelines are dissolved so that acres are not double counted) suggests that linear features, in the aggregate, influence substantial proportions of many SGPAs (Figure 4-7). Buffered linear features encompass over 50% of the acreage of ten SGPAs, and 75% or more of the Mountain Home, West Magic Valley, Curlew, and West Central SGPAs (Table 4-9). While the synergistic effects of linear infrastructure features on sage-grouse are unknown and difficult to predict, it is clear that proposals for further development in this regard should be carefully evaluated.

While an area-based analysis of buffered linear infrastructure features provides one means by which to evaluate the scale of infrastructure on the landscape, another metric is linear density, reported here in feet/acre (Table 4-9). While the biological meaning of particular linear density values to sage-grouse is unknown, the information nevertheless provides a quantitative baseline by which the relative magnitude of infrastructure density can be compared, by SGPA. Certain SGPAs, such as the Jarbidge (0.20 ft/acre) and Owyhee (0.38 ft/acre), show a relatively low linear density, while others are considerably higher (e.g. Mountain Home 2.05 ft/acre; West Magic Valley 2.13 ft/acre).

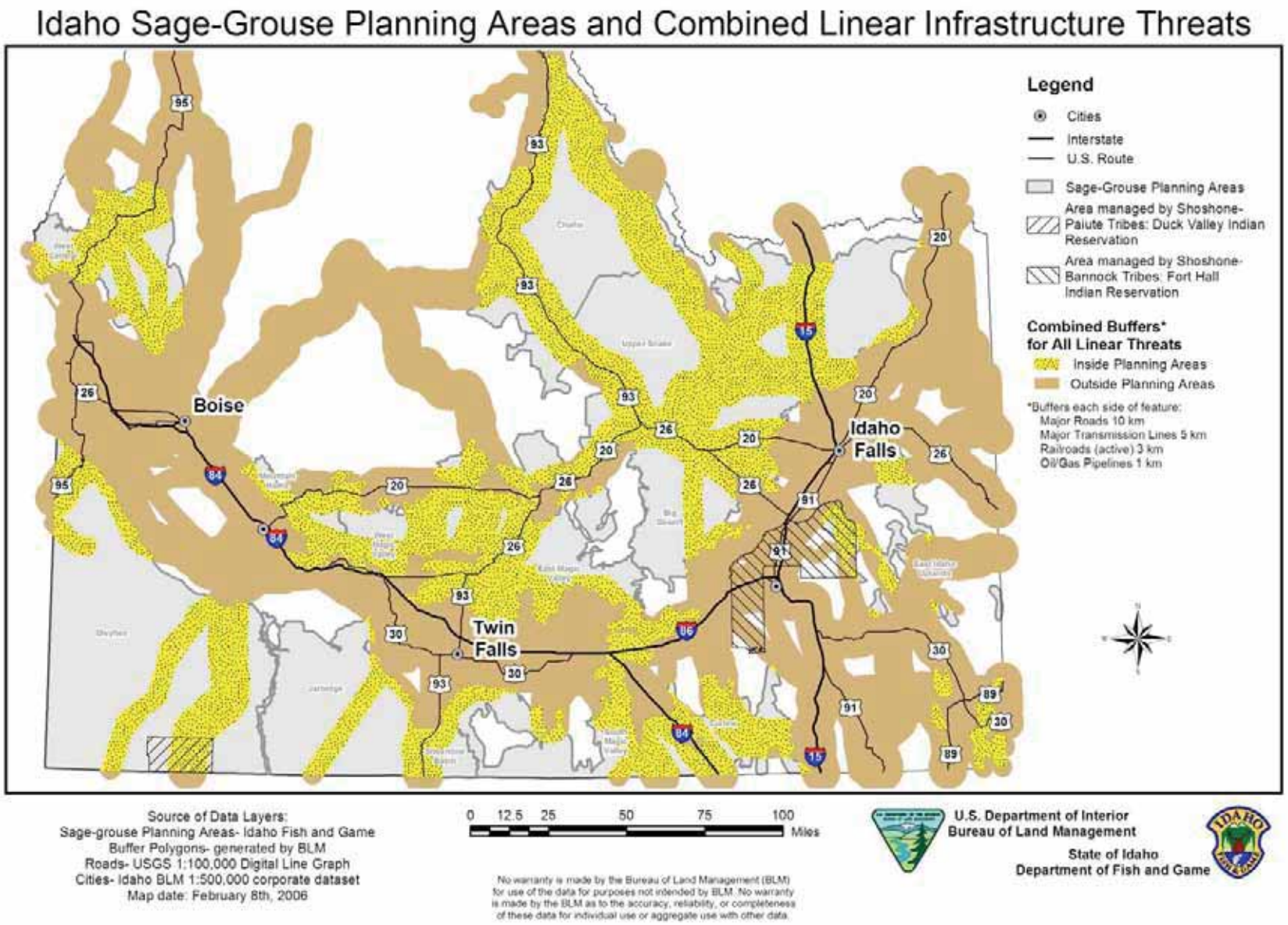


Figure 4-7 Idaho Sage-grouse Planning Areas and combined linear infrastructure threats

Table 4-9 Idaho Sage-grouse Planning Areas and combined linear threat features[22]

COMBINED LINEAR INFRASTRUCTURE BUFFER ANALYSIS				
SGPA Name	**Total acres of SGPA**	**Total Acres of combined linear infrastructure buffers**	**Percentage of SGPA covered by combined linear infrastructure buffers**	**Density of clustered linear features[23] (ft/acre)**
Big Desert Planning Area	884,715.33	417,663.12	47%	0.87
Challis Planning Area	1,826,860.33	1,120,877.34	61%	0.88
Curlew Planning Area	476,227.62	369,487.38	78%	0.70
East Idaho Uplands Planning Area	538,483.11	346,460.34	64%	1.20
East Magic Valley Planning Area	1,410,610.29	978,083.41	69%	1.83
Jarbidge Planning Area	1,250,139.39	227,967.10	18%	0.20
Mountain Home Planning Area	305,934.77	259,317.99	85%	2.05
Owyhee Planning Area	3,230,100.47	1,014,721.41	31%	0.38
Shoshone Basin Planning Area	187,380.44	108,811.86	58%	1.85
South Magic Valley Planning Area	898,358.79	490,758.54	55%	0.75
Upper Snake Planning Area	3,360,620.46	1,870,639.91	56%	1.00
West Central Planning Area	931,953.66	698,214.98	75%	1.48
West Magic Valley Planning Area	774,265.85	631,520.03	82%	2.13
Total	**16,075,650.48**	**8,534,523.41**		

[22] Dissolved buffers for major power lines, major roads, active railroads and oil/gas pipelines.

[23] Linear density based on FRAGSTATS analysis of rasterized Sage-grouse Habitat Planning Map, assuming a 90 m grid cell. Clustered linear features were created by snapping linear features (major roads, major power lines, active railroads, gas/oil pipelines) into one feature if they were within 100 m (328 ft) of one another. Doing so ensures that nearby parallel features are counted only once.

4.3.2.2.3 Nonlinear Infrastructure Features

Two nonlinear infrastructure features evaluated in this Plan include wireless communications (i.e. cellular) towers and structures associated with wind energy development. While these features occupy points or relatively small areas on the landscape, their presence has the potential to disrupt behavior survival or sage-grouse habitat-use. Associated access roads, ground disturbance and increased human presence may also be of concern.

- **Wireless communication towers:** As with power lines, wireless communications towers provide unnatural vertical structure on the shrub-steppe landscape and provide potential perch or nest sites for raptors and ravens. The current distribution of wireless communications towers in Idaho is relatively extensive, but most currently occur along Interstate or other highway corridors outside of SGPAs (USDI BLM 2004*g*; Figure 4-8). Wireless towers nonetheless occur within each SGPA.

- **Wind energy development**: The National Energy Policy established in 2001 encouraged the development of renewable energy sources (National Energy Policy Group 2001). Federal lands in the western United States have significant potential to produce energy from wind (Connelly et al. 2004).

  A number of wind energy-related structures currently exist within several SGPAs including the Owyhee, West Magic Valley, South Magic Valley, East Idaho Uplands, and Challis (USDI BLM 2004*h*; Figure 4-9).

  The majority of these are wind monitoring towers 70 ft or shorter in height. Data available in March 2005 indicate that there currently are no operating turbines within SGPAs. Several sites currently under review for wind energy development in Idaho have the potential to impact sage-grouse, including Brown's Bench (Jarbidge SGPA), Danskin Mountain (Mountain Home SGPA), Glenn's Ferry (Mountain Home/West Magic Valley) and Cotterel Mountain (South Magic Valley SGPA). Other sites may be identified in the future.

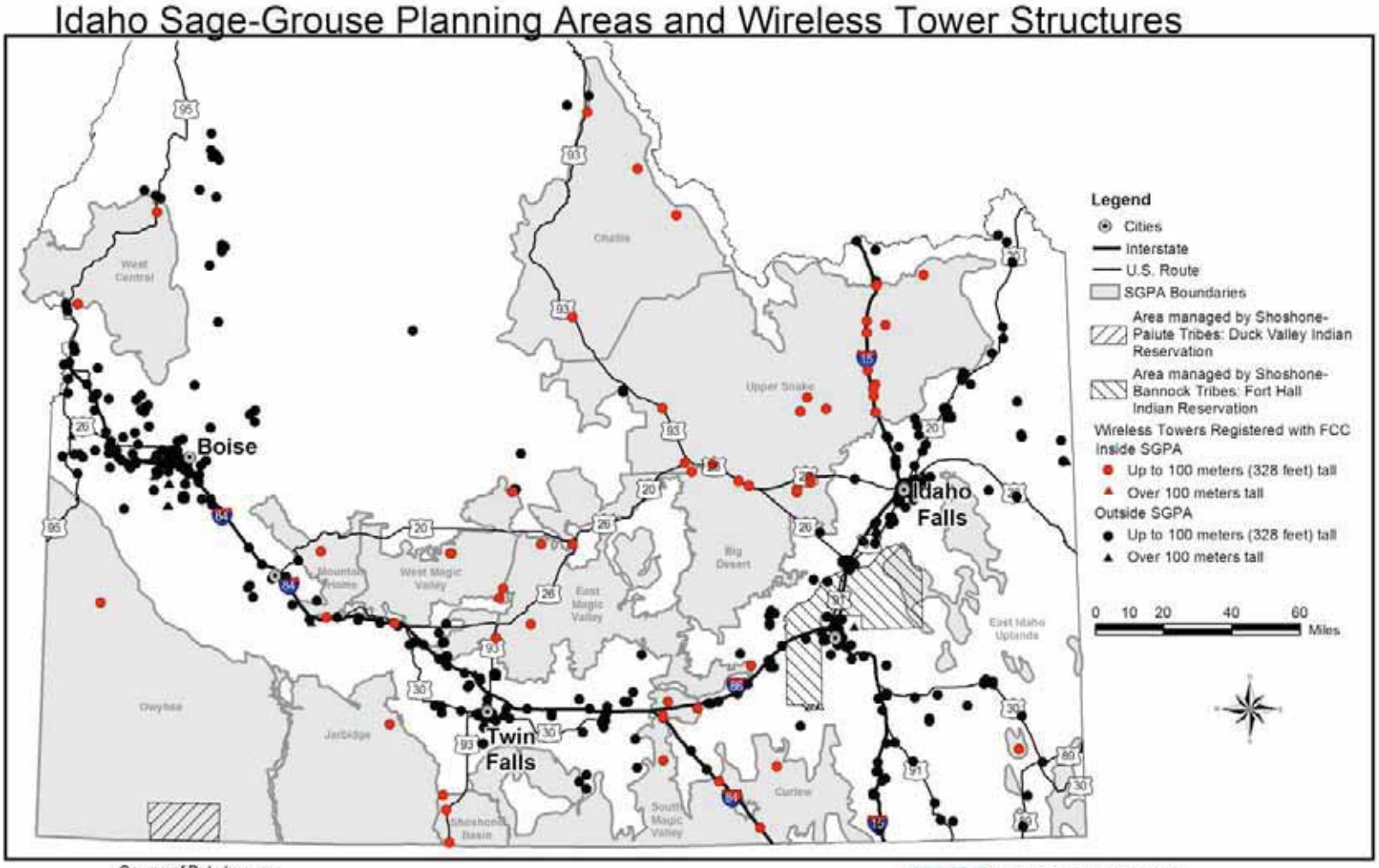
  The effects of wind energy development and associated ancillary facilities (i.e. access roads, utility corridors, transmission corridors) on sage-grouse populations are largely unknown, though a number of direct and indirect impacts have been identified. The Final BLM Programmatic Wind Energy Development EIS (USDI BLM 2005*b*) discusses a number of construction activities that may adversely affect wildlife (sage-grouse). These include: (1) habitat reduction, alteration or fragmentation, (2) introduction of invasive vegetation (3) injury or mortality of wildlife, (4) decrease in water quality from erosion and runoff, (5) fugitive dust, (6) noise, (7) exposure to contaminants, and (8) interference with behavioral activities. Manville (2004)

suggested, "Given the continuing uncertainties about structural impacts on prairie grouse, especially the lack of data regarding impacts from wind facilities, and the clearly declining trends in prairie grouse populations, we urge a precautionary approach by industry and recommend a 5-mile buffer [around active leks] where feasible."

Structures can also provide potential perches and nesting substrates for raptors and ravens (Steenhof et al. 1993). Tall structures and noise associated with wind energy development may also disrupt communication between lekking birds (Manes et al. 2002). It is possible that low frequency noise and/or shadow flicker associated with turbine blades, as described in USDI BLM (2005*b*), could affect sage-grouse behaviorally, especially if in proximity to leks though further information is not available.

4.3.2.2.4 Combined linear and nonlinear infrastructure features

Figure 4-10, illustrates the extent of all six combined nonlinear and buffered linear infrastructure features on the Idaho landscape. The potential for synergistic, cumulative effects of infrastructure features on sage-grouse and sage-grouse habitat is relatively high in some SGPAs, and care should be taken in siting additional proposed projects.



Source of Data Layers:
Sage-grouse Planning Areas- Idaho Fish and Game
Wireless Towers- Berkana Wireless Radio Tower Locator
Roads- USGS 1:100,000 Digital Line Graph
Cities- Idaho BLM 1:500,000 corporate dataset
Map date: February 8th, 2006

No warranty is made by the Bureau of Land Management (BLM) for use of the data for purposes not intended by BLM. No warranty is made by the BLM as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data.

U.S. Department of Interior
Bureau of Land Management

State of Idaho
Department of Fish and Game

Figure 4-8 Idaho Sage-grouse Planning Areas and wireless communication tower structures

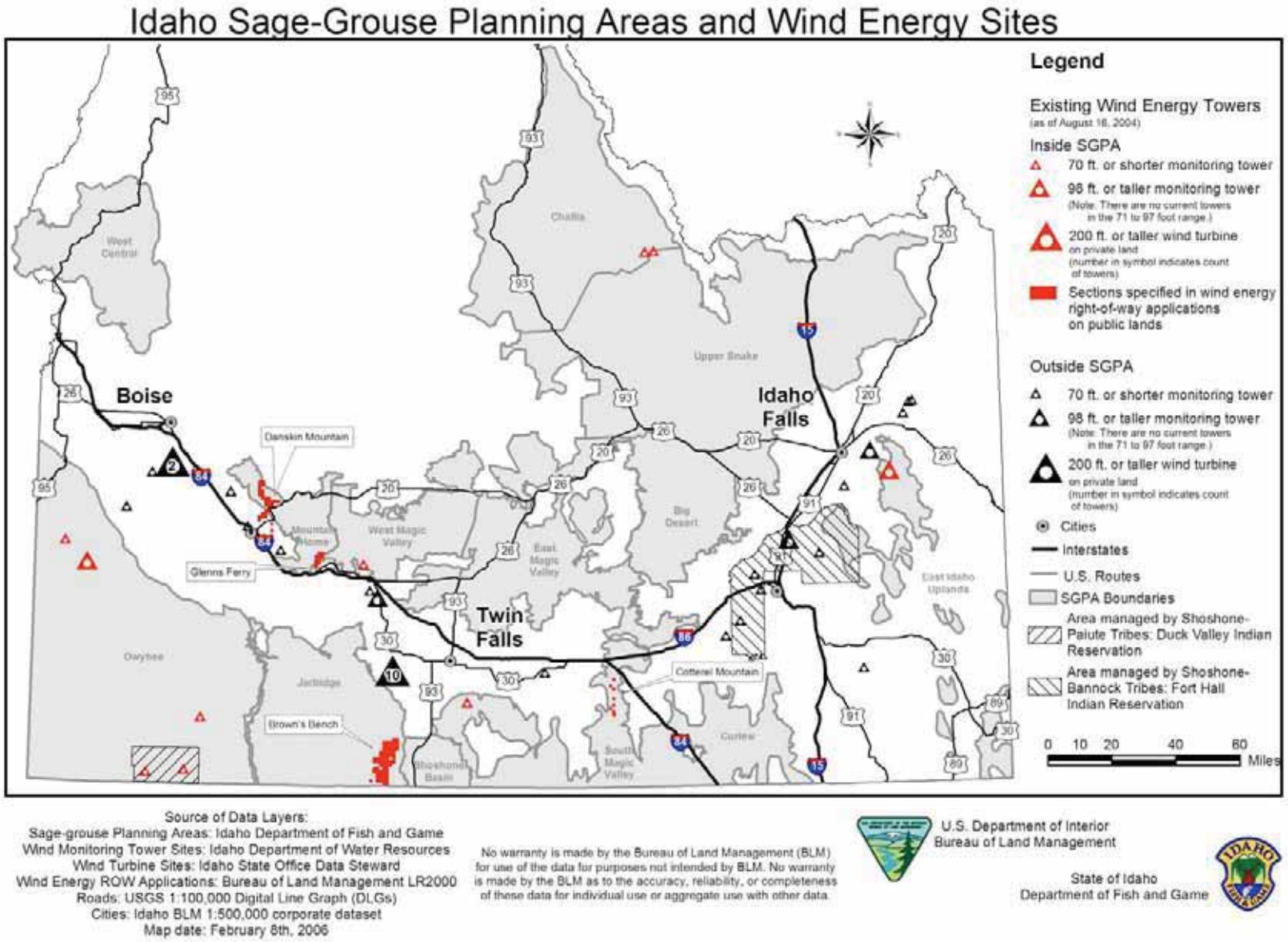


Figure 4-9 Idaho Sage-grouse Planning Areas and wind energy sites

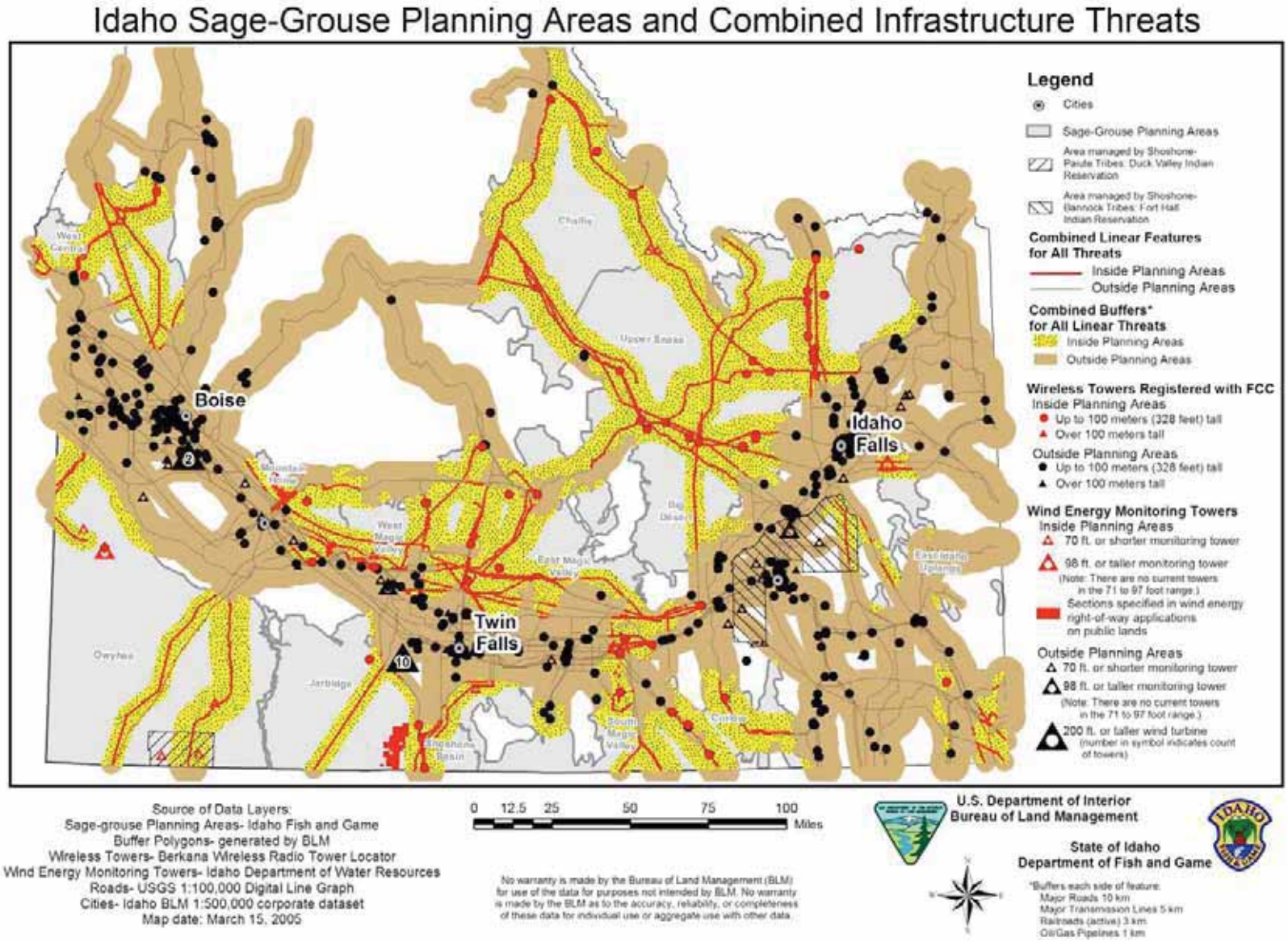


Figure 4-10 Idaho Sage-grouse Planning Areas and combined infrastructure threats

4.3.2.3 Infrastructure conservation measures

Goal: Reduce, minimize, or mitigate adverse impact to sage-grouse populations and habitat through careful planning, design, maintenance and/or modification of infrastructure features.

Issue Addressed	Rationale	Conservation Measure(s)
All infrastructure issues, disturbance to leks.	Human disturbance resulting from construction and maintenance activities can adversely affect breeding sage-grouse.	1. Inspections, maintenance work, and related human activities at or near (1 km or 0.6 miles) occupied leks that results in, or will likely result in, disturbance to lekking birds should be avoided from approximately 6:00 PM to 9:00 AM[24]. Utility companies should work closely with IDFG, land management agencies and landowners in scheduling such activities to minimize disturbance. In general, this guideline should be applied from approximately March 15 to May 1, in lower elevations; and March 25 to May 15, in higher elevations.
Utility lines, communications towers, and related facilities.	Improper placement of utility lines, wireless towers or related structures can disrupt sage-grouse behavior, increase mortality due to collisions, lead to increased avian predation, or spread of invasive vegetation.	1. Use of guy-wires on towers should be avoided. 2. Where existing utility lines, including smaller power distribution lines, telephone lines, or wireless communication towers are known to be causing adverse impacts locally, or where such impacts are likely, LWGs and/or land-management agencies should work closely with power companies and related entities in assessing problem areas and developing creative solutions. 3. New above ground major power transmission lines should be sited in a manner that avoids sage-grouse habitat to the extent possible, or they should be buried. 4. New, smaller power distribution lines, or similar structures (e.g., telephone lines, communications towers) should be buried (as appropriate) or sited as far as possible, preferably at least 3.2 km (~2 miles) from occupied leks and other important sage-grouse seasonal habitats (Connelly et al. 2000*a*), as determined locally. 5. The placement of raptor perch deterrents on power poles and other structures, such as telephone poles, should be considered on a site-specific basis in areas where population impacts from raptors or ravens is likely or is a documented problem. Areas that may be of particular

[24] Timeframe is from Washington State sage-grouse recovery plan. Also, concept is also presented in Connelly et al. 2000*b*.

Issue Addressed	Rationale	Conservation Measure(s)
		concern include fragmented habitats with high raptor and/or raven activity. See "Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996" (APLIC 1996). 6. Utility companies should ensure access roads, rights-of-ways and disturbed areas associated with their facilities are managed in a manner that restores disturbed areas to perennial vegetative cover, and controls the spread of noxious weeds and invasive plant species. Coordinate with land-management agencies and others in selecting the most appropriate plant species. Consider the use of fire-resistant species in high fire-frequency/ cheatgrass areas. Encourage companies to participate in Coordinated Weed Management Areas. LWGs may be of assistance in helping to identify particular problem areas.
Major roads	Roads can result in adverse direct and indirect effects on sage-grouse and habitat including: collisions with vehicles; human disturbance and vehicular noise; habitat loss and fragmentation; increased risk of fire, and invasives.	1. Ensure that new public trails, roads, and highways avoid or skirt areas of key or stronghold habitat (including restoration areas intended to become key/stronghold in the future) to the extent feasible. 2. LWGs should identify specific roads or road sections where sage-grouse mortality has been documented. Work collaboratively with the appropriate agency(s) to develop measures to reduce the risk of road-related mortalities of sage-grouse. Consider speed limits, brush control, signing, and public education. 3. Reduce the risk of vehicle or human-caused wildfires, and spread of invasives, by planting perennial vegetation (e.g. green-strips) paralleling road rights-of-way. This measure is applicable to existing as well as new paved or gravel roads in sage-grouse habitat. The need for the green-strips should be evaluated on a case-by-case basis depending on fire risk, vehicle activity, vegetation type, importance of the area, or other factors. Avoid the use of species palatable to sage-grouse. 4. Manage existing roads and trails to minimize disturbance to occupied leks or other important seasonal habitats. Employ seasonal closures, permanent closures, rerouting of existing roads/trails or other measures, as deemed locally appropriate.

Issue Addressed	Rationale	Conservation Measure(s)
Active railroads	Disturbed areas along railroads can facilitate the establishment and spread of invasive plants. Certain invasives (e.g., cheatgrass) increase the likelihood of wildfire ignitions from trains.	1. Railroad companies should work closely with agencies and private landowners, as appropriate, to reduce or control invasive plants along railroad rights-of way, 2. Railroad companies should work closely with agencies and private landowners to manage fuels along railroad rights-of-way to reduce fire risk. Where cheatgrass or other vegetation along rights-of-way presents a high-fire risk, replace with suitable perennial species.
Gas and Oil Pipelines	Oil/gas pipeline construction can fragment habitat and facilitate the spread of invasive plants.	1. Locate new oil or gas pipelines and related facilities as far as possible, preferably at least 3.2 km (approximately 2 mi) from occupied leks or place along existing corridors to the extent possible. LWGs and/or land-management agencies should work closely with gas/oil companies and related entities in identifying potential problem areas and creative solutions. 2. Oil/gas companies should work closely with agencies and private landowners, as appropriate, to reduce or control invasive plants along pipeline rights-of-way and access roads. This should include ensuring that disturbed areas are seeded to an appropriate perennial seed mix.
Wind Energy Development	Wind energy development involves an array of potential direct and indirect adverse impacts to sage-grouse and sage-grouse habitat.	1. Due to the complexity of wind energy development and related support facilities, we refer the reader to USDI BLM (2005*b*) and USDI FWS (2003) for a more comprehensive list of mitigation measures and site evaluation guidelines. Key conservation measures recommended for Idaho include: A. Wind energy project and design approval should focus on avoiding, minimizing, or restoring habitat degradation (on-site mitigation). Consider one or more of the following specific recommendations: ▪ Avoid placing turbines and related infrastructure in breeding or winter habitat. If turbines must be sited within breeding habitat, avoid placing turbines within five miles of occupied leks where feasible. ▪ Avoid locating turbines and related infrastructure in known sage-grouse movement corridors, migration pathways or in areas where

Issue Addressed	Rationale	Conservation Measure(s)
		sage-grouse are highly concentrated (e.g., wintering areas). ▪ Avoid fragmenting large, contiguous tracts of sage-grouse habitat. Where practical, focus wind energy development on lands already altered or cultivated and away from areas of intact and healthy native habitats. If this is not practical, select fragmented or degraded habitats for development, rather than relatively intact areas. ▪ Minimize roads, fences, or other infrastructure. ▪ Use tubular supports with pointed tops rather than lattice supports to minimize bird (raptor, raven) perching and nesting opportunities. ▪ Avoid placing external ladders and platforms on tubular towers to minimize perching and nesting by raptors and ravens. ▪ To reduce the risk of collisions, avoid the use of guy wires for turbine or meteorological tower supports. All existing guy wires should be marked with recommended bird deterrent devices. ▪ Where feasible, place electric power lines underground or on the surface as insulated, shielded wire to avoid electrocution (and collisions) of birds. 2. Measures to mitigate impacts at off-site locations should also be employed to offset unavoidable alteration and losses of sage-grouse habitat. Off-site mitigation should focus on acquiring, restoring, or improving habitat within or adjacent to occupied habitats and ideally should be designed to complement local sage-grouse conservation priorities. 3. Where wind energy development within sage-grouse habitat is unavoidable, monitor sage-grouse populations and habitat (a) for at least 3 years before project construction; (b) during construction, and (c) for at least 3 years after construction is completed and implementation has begun, to complement the existing knowledge of impacts and to help in the design of future conservation measures. Industry proponents should work closely with IDFG, land-management agencies,

Issue Addressed	Rationale	Conservation Measure(s)
		private landowners and LWGs, in designing the appropriate monitoring strategy.

Research, monitoring or evaluation needs: Research the avoidance distance of sage-grouse to utility lines and the incidence of, and effect of, avian predation due to utility lines. Evaluate sage-grouse response to new and existing power lines as related to habitat conditions and avian predator densities. Research/monitor the effects of wind energy development in sage-grouse habitats with respect to sage-grouse survival, habitat-use and behavior including: abandonment of leks, nesting, brood rearing or winter habitat and the distance from the wind turbines that effects are experienced. Of additional interest are the effects of low frequency noise, shadow flicker, presence of tall structures etc. Map and quantify secondary and other roads (e.g., paved county, gravel, two-tracks), smaller power distribution lines (< 138 kv), telephone lines in SGPAs. Identify specific potential problem areas. Identify utility, railroad, and road rights of way where invasive plants increase fire risk. Research or model the synergistic effects of multiple infrastructure features on sage-grouse survival, habitat use, and behavior. Document the incidence and extent of avian predation on sage-grouse nest success, and juvenile and adult survival in areas with extensive infrastructure and areas without extensive infrastructure. Evaluate sage-grouse response to new and existing power lines as associated with habitat conditions and avian predator densities.

4.3.3 Annual grassland

4.3.3.1 Threat summary and background

The proliferation of invasive annual species, particularly cheatgrass, in portions of Idaho (e.g., Wisdom et al. 2000), poses a significant threat to sage-grouse and sage-grouse habitat. Within the five-state area of Washington, Oregon, Idaho, Utah, and Nevada, cheatgrass and medusahead rye dominate or have a significant presence (>10% composition by weight) on approximately 70,000 km^2 (17,297,000 acres) of public land (Connelly et al. 2004). The spread of invasive annual grasses has been most extensive in the Wyoming big sagebrush cover type (Crawford et al. 2004). Risk of invasion increases below elevations of 1,500 m (4,920 ft), and is extreme below 1,000 m (3,280 ft) (Crawford et al. 2004). Exotic annual grasses do not usually dominate more mesic, cooler mountain big sagebrush or low sagebrush communities (Crawford et al. 2004). However, regardless of elevation, exotic annual grasses should be monitored closely. The competitive influence exerted by invasive annuals enables them to dominate vast areas for many years (Monsen et al. 2004). In Idaho, the majority of the Snake River Plain shows a moderate to high risk of cheatgrass displacement of sagebrush over the next 30 years (Connelly et al. 2004). For a detailed discussion on the history, ecology and risk of cheatgrass expansion, see Suring et al. (2005). While annual grasslands are the focus of this section, noxious weeds also pose a threat to sage-grouse habitat, and are discussed briefly in the Climate Change section.

4.3.3.2 Summary of key conservation issues

- **Spatial extent of annual grasslands on the landscape**: Several large areas of annual grassland are evident across southcentral, southwestern and western Idaho (Figure 4-11), and comprise nearly one million acres within SGPAs (Table 4-10). In general, these figures represent only larger areas with dominance or significant presence of annual grasslands. Smaller inclusions or areas where annuals are present but not dominant may not be well represented due to the difficulties associated with mapping habitats at the mid-scale. As mapping technologies and field inventory efforts improve, additional refinements will be incorporated. Several SGPAs show a particularly strong presence of annual grasslands. Approximately 41% of the total annual grassland acreage is in the adjacent West Magic Valley, East Magic Valley, and Big Desert SGPAs. Substantial acreages are also associated with the Owyhee, Mountain Home, and West Central SGPAs. Land ownership of identified annual grasslands is BLM (62%), BLM National Monument (3%), private (29%), and state (6%). Other ownerships constitute a negligible proportion. Given the magnitude of annual grassland acreages on the Idaho landscape, the restoration of these lands to a

point where they are again suitable for sage-grouse requires a long-term commitment of funding and personnel resources. Several research projects underway in conjunction with the Great Basin Restoration Initiative will contribute to the understanding of how to effectively restore diverse, functional rangelands. Projects include the Great Basin Native Plant Selection and Increase Project; Coordinated Intermountain Restoration Project, Integrating Weed Control and Restoration for Great Basin Rangelands Project; and A Regional Experiment to Evaluate Effects of Fire and Fire Surrogate Treatments in the Sagebrush Biome.

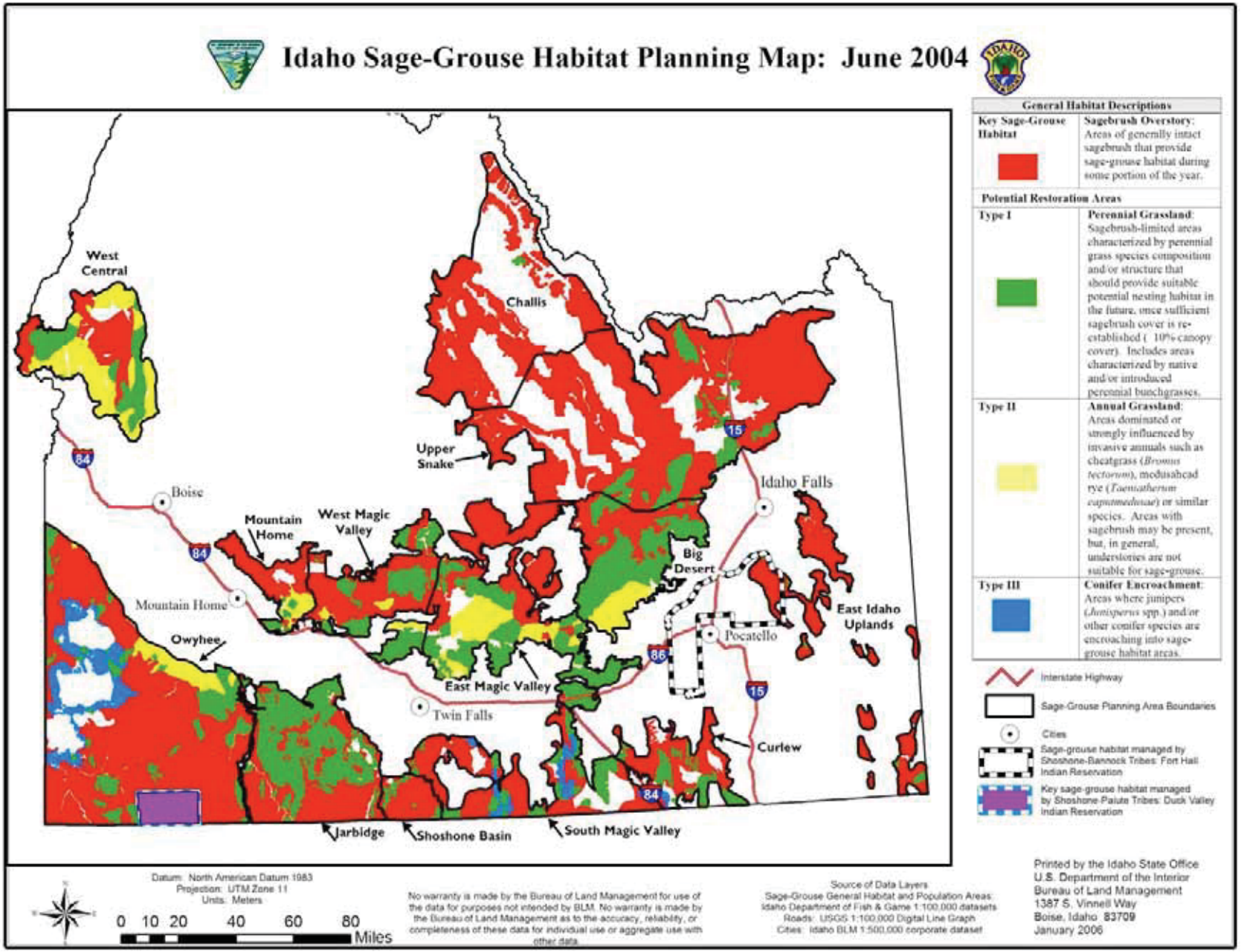


Figure 4-11 Idaho Sage-grouse Habitat Planning Map. Yellow areas indicate annual grasslands.

Table 4-10 Annual grasslands by Idaho SGPA and land-ownership status (USDI-BLM 2004*a*)

	Land-ownership status[25]										
SGPA	**BLM**	**BLM NM**	**BIA**	**USFS**	**Other**	**MIL**	**NPS**	**Private**	**IDL**	**USFWS**	**Total**
Big Desert	89,584	14,983	0	0	0	0	961	19,676	6,165	0	131,369
Challis	0	0	0	0	0	0	0	0	0	0	0
Curlew	0	0	0	0	0	0	0	0	0	0	0
East Idaho Uplands	0	0	0	0	0	0	0	0	0	0	0
East Magic Valley	207,028	14,729	0	0	963	0	154	4,126	10,732	0	237,732
Jarbidge	675	0	0	0	0	0	0	3	0	0	678
Mountain Home	46,837	0	0	0	0	0	0	5,979	2,476	0	55,292
Owyhee	128,628	0	0	0	0	0	0	3,153	7,846	0	139,627
Shoshone Basin	0	0	0	0	0	0	0	0	0	0	0
South Magic Valley	0	0	0	0	0	0	0	0	0	0	0
Upper Snake	0	0	0	0	0	0	0	0	0	0	0
West Central	107,120	0	0	151	0	0	0	255,399	26,333	0	389,003
West Magic Valley	38,120	0	0	0	0	0	0	3,895	2,414	0	44,429
Total	617,992	29,712	0	151	963	0	1115	292,231	55,966	0	998,130

[25] BLM: Bureau of Land Management; BLM NM: BLM-administered lands associated with Craters of the Moon National Monument; BIA: Bureau of Indian Affairs; USFS: U.S. Forest Service; Other: miscellaneous; MIL: Military; NPS: National Park Service; IDL: Idaho Department of Lands; USFWS: U.S. Fish and Wildlife Service. Acreages are approximate only and are reflective of the relatively broad nature of the 2004 SGHPM.

- **Degraded habitat quality including rangeland health**: In general, invasive annual grasses can proliferate and out-compete native grasses, forbs, and shrubs for nutrients and water resulting in less diverse plant communities in terms of species composition and structure. This simplified plant community structure and altered species composition (e.g., fewer shrubs or native perennial grasses and forbs, more weedy species) can degrade habitat quality and quantity by reducing the availability of desirable plant species needed by sage-grouse for cover or food.

- **Altered fuels and fire regimes**: Cheatgrass and medusahead rye can alter fire regimes by increasing fine-fuel loads and greatly shortening fire-return intervals, hindering perennial grasses, sagebrush, or other shrubs from establishing or setting seed (Laycock 1991). Dominance of sites by these annuals may result in stable, resistant vegetation states with thresholds (for recovery or restoration) that are difficult to cross (Laycock 1991). Recovery or restoration of these areas typically requires concerted management intervention.

4.3.3.3 Annual grassland conservation measures

Goal: To restore areas dominated or strongly influenced by annual grasses to a diverse mix of perennial native grasses, forbs, and shrubs, where feasible.

Issue Addressed	Rationale	Conservation Measure(s)
Spatial extent of annual grasslands on the landscape *AND* degraded habitat quality including rangeland health	Annual grasslands do not provide suitable habitat to meet the seasonal habitat needs of sage-grouse	1. LWGs, land management agencies, IDFG and other partners should work closely together to identify and prioritize annual grassland areas for restoration. Work cooperatively to identify options, schedules and funding opportunities for specific projects. 2. In general, the priority for implementation of specific sage-grouse habitat restoration projects in annual grasslands should be given first to (1) sites adjacent to or surrounded by sage-grouse stronghold habitats, then (2) sites outside stronghold habitats but adjacent to or within approximately two miles of key habitat, and last (3) sites beyond two miles of key habitat. The intent here is to focus restoration outward from existing, intact habitat. 3. As funding and logistics permit, restore annual grasslands to a species composition characterized by perennial grasses, forbs and shrubs. Emphasize the use of native plant species recognizing that non-native species may be necessary depending on the availability of native seed and prevailing site conditions. Multiple treatments may be required. See Monsen et al. (2004), Dalzell (2004), and the seeded Perennial Grassland

Issue Addressed	Rationale	Conservation Measure(s)
		Section 4.3.8, for helpful suggestions on restoration techniques. Lambert (2005) also provides descriptions, recommended seeding rates, and other useful information for nearly 250 species of native and non-native grasses, forbs and shrubs. 4. The eradication or control of noxious weeds posing a risk to sage-grouse habitats should also be aggressively pursued using a variety of chemical, mechanical, biological, or other means as appropriate. All seeding project designs should include measures for noxious weed control and monitoring for at least 3 years following implementation. 5. Seed utilized in sage-grouse habitat restoration seedings, burned area rehabilitation projects, and hazardous fuels/wildland urban interface projects will be tested and certified as weed-free, based on prevailing agency policy and protocol. Private landowners are encouraged to utilize only certified seed as well. 6. To discourage the spread of invasive annuals and noxious weeds, require the use of certified weed-free forage by Permitted users (outfitters, guides, livestock operators) and by casual users (e.g., recreation trail riders, hunters) utilizing horses, goats, or llamas on public or state lands. 7. On private lands, consider enrolling in incentive or other programs to improve or enhance sage-grouse/ sagebrush habitats. Current NRCS programs that may provide some opportunities for economic offset of certain conservation measures include the Conservation Security Program (CSP), the Wildlife Habitat Incentive Program (WHIP), and the Environmental Quality Incentive Program (EQIP). Funding may also be available for certain private lands projects through BLM's hazardous fuels program or through IDFG and OSC. Landowners are encouraged to discuss the various opportunities available with their local NRCS, IDFG, or BLM office. Support for Idaho projects may also be available through the North American Grouse Partnership's (NAGP) Grouse Habitat Restoration Fund. Interested parties should contact Mr. Kent Christopher at (208) 356-0079 or grouse@fretel.com. 8. In designing rehabilitation and restoration projects, utilize the best available science relative to seeding technology and plant materials. Use of NRCS's "VegSpec" website may be helpful. VegSpec is a web-

Issue Addressed	Rationale	Conservation Measure(s)
		based decision support system that assists land managers in the planning and design of vegetation establishment practices. VegSpec utilizes soil, plant, and climate data to select plant species that are site-specifically adapted, suitable for the selected practice, and appropriate for the purposes and objectives for which the planting is intended. (See http://plants.usda.gov)
Altered fuels and fire regimes	Annual grasses increase the risk of fire ignition and rate of spread.	1. Design vegetation treatments in areas of high fire frequency to facilitate firefighter safety; reduce the risk of extreme fire behavior; reduce the risk and rate of fire spread to stronghold, key, and restoration habitats; reduce fire frequencies; and shorten the fire season. Actions may include: fire-resistant or "green-strip" seedings, mowing vegetation along roadsides, grazing strategies, or other related measures. 2. Where rangelands are dominated by annuals (such as cheatgrass), or border farmlands or railroad rights-of-way, convert cheatgrass areas to perennials, or establish buffers of perennial species to reduce the risk of fire spread from railroad or agriculture-related activities (e.g. sparks from trains, field burns, burn barrels), where appropriate and feasible. However, to retain their effectiveness greenstrips must be monitored as well as maintained, such as through grazing, so fuel loads do not build up over time (Younkin-Kury 2004). 3. To discourage the spread of invasive annuals and noxious weed seed, require the washing of fire vehicles (including undercarriage) prior to deployments and prior to demobilization from wildfire incidents. 4. Ensure annual grass restoration priority areas are incorporated into FMPs, updated annually, as priority fuels treatment and ESR project areas.

Research, monitoring or evaluation needs: Cooperate with the Great Basin Restoration Initiative, universities, local partners and others, as appropriate, in researching new plant materials and restoration methods. Develop a consistent approach for monitoring, evaluating and reporting restoration efforts.

4.3.4 Livestock impacts

4.3.4.1 Threat summary and background

Livestock grazing occurs on the vast majority of sagebrush lands range-wide (Knick et al. 2003, Connelly et al. 2004); however, there is little information directly linking livestock management practices to sage-grouse population levels (Braun 1987, Connelly and Braun 1997, Mosley 2001). Beck and Mitchell (2000) discuss various direct and indirect effects of livestock on sage-grouse. Only a few studies have addressed the impacts of livestock grazing on habitat use by sage-grouse (Crawford et al. 2004). Experimental research related to the impacts of specific grazing practices on sage-grouse habitat quality and sage-grouse productivity is warranted. Research currently underway in Idaho will help refine our understanding of sage-grouse nesting habitat in various areas across the state.

Historically, poor livestock grazing practices have negatively impacted some sage-grouse habitat. These impacts have included changes to the proportion of the shrub, grass, and forb functional groups; increased opportunities for invasion and dominance of introduced annuals; shortening of the growing season (e.g., through a shift from perennials which stay green longer into the growing season- toward annuals which go to seed and desiccate early in the growing season); and in some cases an overall decline in site potential through loss of topsoil (Miller and Eddleman 2001).

Connelly et al. (2004) suggested the impacts of livestock are spread unevenly across the landscape in space and time and may positively or negatively affect the structure and composition of sage-grouse habitat. In general, livestock management practices that promote the sustainability of desired native perennial grasses and forbs should maintain or minimally impact sage-grouse habitat. Miller and Eddleman (2001) summarized the inherent complexities of developing grazing management plans that are compatible with sage-grouse:

> *Grazing management practices, which maintain the integrity of sagebrush communities, can have positive, neutral or negative impacts on sage-grouse habitat. Season, duration, distribution, intensity of use, and class of livestock (e.g. cattle, sheep, etc.) will determine the effects of grazing on sage-grouse food and cover. Plant composition and structure at the community and landscape levels will also affect potential interactions between livestock and sage-grouse. Spatial and temporal heterogeneity of the landscape will affect abundance and grazing distribution. Topography, size and shape of pastures, and distribution of salt and water will also influence grazing distribution. All of these factors must be considered when developing grazing management plans sensitive to sage-grouse habitat requirements.*

In situations where the current vegetation community controls successional pathways (e.g., cheatgrass-dominated areas), it can be expected that changes in livestock grazing management strategies or even the complete removal of grazing activity will not result in the improvement of some ecological states. Seral or post-settlement juniper stands or dense canopies of sagebrush that suppress both the shrub and herbaceous understory will not change in the short term without human intervention to restore or mimic historic disturbance regimes (e.g., wildfire). In such cases, the use of vegetation management tools including prescribed fire, mechanical removal, thinning, or other means will be necessary. Similarly, annual grasslands, often perpetuated by frequent wildfires in the more arid Wyoming big sagebrush ecological sites, are a stable state that typically require significant and often long-term human intervention to effect restoration. This intervention often requires the application of herbicides or other treatments to reduce or eliminate annuals, followed by the seeding of desired perennial species. While subsequent changes in livestock management may be appropriate to nurture and maintain the restored area, such changes alone in the absence of restoration activities would likely provide little if any progress.

In some arid areas of the west, measurable improvement of upland herbaceous vegetative conditions is a difficult process and represents a long-term management commitment. Due to the difficulty of restoring desirable vegetative conditions, the importance of maintaining currently good sage-grouse habitat is especially vital. For this reason, a primary management objective in these areas should be to maintain the condition and geographical range of currently suitable sage-grouse habitat and sagebrush communities.

As a general approach, healthy, functioning rangelands provide most, if not all, of the habitat components comprising suitable sage-grouse habitat relative to site potential. Therefore, the primary focus for conservation and improvement of sage-grouse habitat is consistent with long-term grazing management programs that support ecological conditions or trends toward healthy rangelands. Livestock management practices are not stand-alone actions but are considered in combinations that best represent a complete and effective grazing program that fully considers key sage-grouse conservation needs.

4.3.4.2 Summary of key conservation issues

The many variables associated with livestock related impacts to sage-grouse populations and habitat are complex and often interrelated. Historically, livestock over-stocking on some rangelands in the West altered the composition and productivity of some sagebrush and vegetative communities. However, implementation of improved grazing management practices including control of the timing, intensity, duration and frequency of grazing use, as well as the sequence of these treatments over time, have improved

vegetative conditions on many rangelands. The following summary presents some of the key livestock related conservation issues that affect sage-grouse populations and sage-grouse habitat.

- **Livestock management and rangeland health**: Rangeland health is defined as "*the degree to which the integrity of the soil and ecological processes of rangeland ecosystems are maintained*" (National Research Council, 1994). In general, healthy rangelands can also provide a basic foundation for productive sage-grouse habitat. Rangelands in an unhealthy or declining condition due to improper livestock management (and possibly a combination of additional factors) may have lost, or are at risk of losing, key habitat components such as desirable perennial bunchgrasses and forbs.

  Idaho BLM, which has management responsibility for approximately 60% of sage-grouse habitat in the state, is in the process of evaluating rangeland health on each grazing allotment. As of the 2004 field season, Idaho BLM had completed evaluations of approximately 63% of its lands with the remaining 37% scheduled for completion in the next several years.

  Of 7,381,769 acres of Idaho BLM lands assessed (note: these lands are not exclusively sage-grouse habitat) between the 1999 field season and September 30, 2004, approximately 36% constituted lands that met all Idaho BLM standards or were making significant progress toward meeting standards (USDI-BLM 2004*j* Idaho Annual Rangeland Report). Another 47% of the acreage assessed during that timeframe was determined as not meeting all standards due to livestock grazing, or making significant progress at the time, however, appropriate action has been taken to ensure significant progress toward meeting the standards. Seven percent of the lands assessed were categorized as not meeting standards, and livestock is a significant factor, but actions needed to ensure significant progress towards meeting the standard(s) are pending implementation prior to the next grazing season. Ten percent of the area assessed did not meet all standards, or were not making significant progress toward meeting standards, however this was due to factors other than livestock grazing. Approximately 4,424,073 Idaho BLM acres have not yet been assessed.

- **Livestock management and herbaceous plant canopy cover:** Grass height and cover have been identified as two important components of sage-grouse nest sites (Connelly et al. 2000*b*). For example, in the Big Desert of southeastern Idaho, Wakkinen (1990) reported taller grasses occurred near nests compared to random locations. In southwestern Idaho's Owyhee County, Wik (2002) reported that successful nests had taller grass than did random plots. Such herbaceous cover may provide scent, visual, and physical barriers to potential predators (DeLong et

al. 1995). In Idaho, overall sage-grouse nest success is not considered a widespread problem averaging over 49% (Connelly et al. 2004).

The degree of impact that livestock grazing has on herbaceous cover, in the context of sage-grouse breeding habitat conditions is dependant on timing, intensity of use, vegetation composition, and other factors.

- **Livestock management and leks:** The practice of bedding and herding domestic sheep on or near occupied leks may pose a threat, although at this time the threat has not been quantified in Idaho. Also, the presence of sheep bands on or near leks during lek surveys, has been observed across the state and can interfere with sage-grouse breeding activities as well as hinder population monitoring efforts. Concentrations of sheep and the associated presence of herders and guard dogs in the vicinity of leks disturbs lek activity or hens nesting in the vicinity of leks (Patterson 1952).

- **Livestock management and late brood-rearing habitat:** Connelly et al. (2004) provide an extensive literature review on this topic. In general, forb diversity and cover are shown to be extremely important for sage-grouse. In Idaho, Apa (1998) found sites used by sage-grouse broods had twice as much forb cover as did independent sites. Broods in Idaho typically move up in elevation, following the gradient of food availability (Klebenow 1969). Late brood habitats are generally characterized by relatively moist conditions with succulent forbs in or adjacent to sagebrush cover (Connelly et al. 2000*b*). Broods also have been documented to utilize wet meadows and irrigated farmlands adjacent to sagebrush habitats (Gates 1983, Connelly et al. 1988). On the Sheldon National Wildlife Refuge in Nevada, sage-grouse used grazed meadows significantly more during late summer than ungrazed meadows because grazing had stimulated the regrowth of forbs (Evans 1986). Increased forb availability may allow hens to remain in upland brood-rearing habitats longer, which could contribute to increased chick survival due to decreased brood movements (Coggins 1998). Certain livestock management practices or poor habitat conditions that reduce the availability of forbs are of potential concern.

- **Livestock management during periods of drought:** Drought reduces vegetation productivity and water availability causing both short and potentially long-term impacts to nesting, early, and late brood habitat. In drought, forage production may be reduced by more than 50% compared to the annual average (Holechek et al. 2004). Therefore, during drought, the impacts of livestock grazing on upland herbaceous cover may be greater than usual due to already reduced vegetative productivity. Impacts to springs, seeps, and riparian habitats may also increase due to concentrations of livestock. Inadequate management of livestock during drought may also hinder post-drought recovery of upland

perennial plants since root reserves may be limited. Post-drought management is also important to facilitate recovery of drought-stressed plants.

- **Placement of salt and mineral supplements:** The placement of salt and supplements may positively or negatively affect sage-grouse and sage-grouse habitat. Supplements and salt are regularly used to improve livestock distribution. Associated ground disturbances, however, can in some cases negatively impair nearby nesting habitat quality, or create opportunities for the establishment of invasive plants.

- **Placement of fences and other structures:** Sage-grouse are adapted to landscapes with few vertical obstructions or features but currently inhabit areas with many miles of fence (Connelly et al. 2004). Fences can influence predator movements or facilitate the spread of exotic plants (Connelly et al. 2004). Fences and other structures can also pose a hazard to sage-grouse, as they can provide perch sites (posts) for raptors, or grouse may be injured or killed as a result of collisions with wires (Connelly et al. 2004). Fences in proximity to occupied leks or other important habitats or that bisect movement corridors (e.g., low areas or passes used during migratory movements) may be of particular concern.

  While fences pose some potential threat, they are often useful in the development and implementation of grazing management programs intended to achieve overall improvement of sage-grouse habitats. In grazed areas, fences may be used to enhance late brood habitat through exclusion of spring sources and creation of riparian pastures where grazing use can be more carefully controlled. Since the impact of individual fences has not been quantified, grazing managers should consider new or existing fences on a site-specific basis relative to sage-grouse.

- **Design and placement of water developments:** Water developments and the distribution of water sources substantially influence the movements and distribution of livestock in arid western habitats (Valentine 1947, Freilich et al. 2003). Consequently, water developments, depending on their placement and design, can increase or decrease the impact of livestock on sage-grouse habitat.

  Water developments pose a potential threat if troughs or tanks are not equipped with wildlife access and escape ramps to prevent sage-grouse from drowning. Spring developments can disrupt or diminish the free flow of water if not designed properly, adversely affecting wet meadows or other moist areas used by foraging grouse (Connelly et al. 2000*b*).

  Diminished water flows may also reduce available surface water for drinking, though the importance of this issue has been questioned. While some have suggested that access to water may also be important (Girard 1937, June 1963,

Goebel 1980, Hanf et al. 1994 cited in Schroeder et al. 1999), others have contended that succulent vegetation may provide sufficient moisture (Batterson and Morse 1948, Trueblood 1954, Nelson 1955, Wallestad 1971, 1975).

Therefore, water developments in sage-grouse habitat should be carefully analyzed and designed to accommodate the needs of grouse, as well as to facilitate sound grazing systems. Water storage and conservation practices should be used to promote and retain the wetland characteristics of associated springs and other water sources.

- **Livestock management during rehabilitation and restoration efforts:** Substantial areas of Idaho are undergoing, or are in need of, restorative efforts to replace annual grasslands with desirable perennial grasses, forbs, and shrubs. It may also be desirable to diversify certain existing exotic perennial grass seedings (e.g., crested wheatgrass) by increasing the shrub, forb or perennial grass component or by conversion to a mix of native grasses and forbs. There are currently insufficient alternative forage reserves to support large restoration efforts during recovery periods. Therefore, forage reserves, economic incentives, or similar measures to help livestock operations remain viable while newly seeded areas are treated and rested from use will be necessary. These measures could also be used to facilitate other resource objectives such as riparian recovery or to provide rest to improve herbaceous cover in certain nesting or brood habitat areas.

  In addition, rest-requirements associated with burned area fire rehabilitation seedings often require livestock operators to seek forage elsewhere if alternative forage or other options are not available. Currently, the availability of forage reserves in Idaho is extremely limited. Without the development of additional reserves, economic incentives, or other processes, the restoration of Idaho's annual grasslands and diversification of exotic perennial grass seedings will proceed slowly, and both operators and sage-grouse will continue to remain at risk of wildfires and their associated after-effects.

4.3.4.3 Livestock impact conservation measures

Goal: Manage grazing to maintain soil conditions and ecological processes necessary to protect and maintain properly functioning sagebrush communities that meet the long-term needs of sage-grouse and other sagebrush associated species.

Issue Addressed	Rationale	Conservation Measure(s)
Livestock management and rangeland health	Some livestock management practices impair	1. Use established scientifically based agency protocols and procedures for evaluating rangeland health and sage-grouse habitats.

Issue Addressed	Rationale	Conservation Measure(s)
	rangeland health.	2. Establish specific habitat objectives and implement effective grazing management practices and/or vegetative manipulation to achieve those objectives and maintain or improve vegetation conditions or trends. 3. Provide private landowners with incentives when and where appropriate to achieve sage-grouse objectives.
Livestock management and herbaceous plant canopy cover	In some cases, livestock grazing may reduce the availability of suitable nesting or early brood-rearing habitat.	1. If fine-scale habitat assessments or monitoring indicates that current livestock grazing practices are limiting sage-grouse nesting habitat quality and/or quantity (see Chapter 5) and/or reproductive success by limiting herbaceous understory characteristics - design and implement grazing management systems that maintain or enhance herbaceous understory cover, height, and species diversity that occurs during the spring nesting season. Grazing systems must be consistent with ecological site characteristics and potential. The primary objective is to provide desirable perennial grass and perennial forb cover during the spring nesting season (approximately April 1-June 15 in much of Idaho, see Chapter 5 for additional discussion). Design management programs to minimize grazing effects on the cover and height of primary forage species in occupied habitat during the nesting season. The following is a list of management actions or strategies that should be considered and employed singly or in combination, where appropriate, in the development and implementation of grazing management programs: A. Reduce stocking rates or rest breeding habitat areas where appropriate. B. If the area is lacking or deficient in herbaceous cover, reduce livestock utilization, immediately prior to and during, the nesting season. C. Employ grazing management systems that ensure adequate nesting habitat within the breeding landscape. D. When use pattern mapping or monitoring shows opportunity to adjust grazing use distribution to benefit occupied sage-grouse breeding habitat, include as appropriate herding, salting and water source management (e.g., turning troughs/pipelines

Issue Addressed	Rationale	Conservation Measure(s)
		on/off, extending pipelines/moving troughs) in grazing management programs. E. When available and feasible, utilize exotic perennial grass seedings and/or annual grasslands to avoid breeding season use of occupied sage-grouse habitat. F. When alternative forage is available and/or other incentives can facilitate changes, delay spring turnout to reduce grazing use of occupied breeding habitat. G. Use NRCS incentive programs as related to private lands and sage-grouse/sagebrush habitats. Current programs that may provide some opportunities for economic offset of certain conservation measures include the CSP, WHIP, and EQIP programs. Landowners are encouraged to discuss the various opportunities available with their local NRCS district conservationist. H. Develop strategically located forage reserves (seedings) to shift early season livestock-use. (Note: the establishment of such forage reserves may be particularly relevant in areas that have minimal or no potential for sage-grouse habitat restoration.) I. Where circumstances allow (e.g., existence of suitable alternate spring grazing sites, specific livestock management schemes, economic incentives, etc.) consider eliminating spring grazing in sage-grouse habitat. J. Permanently exclude livestock from certain important sage-grouse nesting areas through fencing (i.e., to protect native ranges within exotic seedings). K. Where appropriate maintain residual herbaceous vegetation at the end of the grazing season to contribute to nesting and brood-rearing habitat during the coming nesting season.
Livestock management and leks.	Bedding of sheep bands on or near leks can disturb breeding grouse and interfere	1. Use lek route or other relevant information to identify leks where the placement of sheep camps, bed grounds, herding or related activities is repeatedly disturbing displaying birds on active leks. Dates of concern are from March 15 through May 1 in lower elevation

Issue Addressed	Rationale	Conservation Measure(s)
	with lek/ population monitoring.	habitats and March 25 through May 15 in higher elevation habitats. Once such leks are identified, land management agencies should work closely with sheep ranchers, LWGs and the IDFG to identify mutually agreed upon alternative sites or herding routes that eliminate or reduce disturbance. In selecting such alternative sites/routes, focus on areas away from leks and that do not provide breeding habitat characteristics, where feasible. If such lek-specific conservation measures cannot be developed (due to time or logistical constraints), domestic sheep grazing activities described above will be avoided within the lesser of 0.5 mile or direct line of sight of any such lek during the lekking periods. 2. Ensure that sheep operators and herders are aware of the location of occupied leks. Show operators/herders these locations in the field, provide maps, or mark the perimeter of occupied leks, etc. as appropriate).
Livestock management and late brood-rearing habitat.	Livestock grazing may reduce the availability of suitable late brood-rearing habitat.	1. Due to the preference of forbs by domestic sheep, manage sheep allotments using grazing management techniques that promote and maintain a diversity of desirable annual and perennial forbs. Suggestions include: A. Alternate or rotate areas for spring turnout. B. Promote light, once-over use of vegetation, as opposed to repeated use during the same season by the same band or successive bands of sheep. C. Ensure that permittees, foremen, herders and sheep camp tenders are informed of management and movement requirements, such as related to the avoidance of recent burns, burned area rehabilitation seedings or other restoration sites. D. Employ open (loose) herding of sheep as opposed to tightly bunched sheep. 2. Manage grazing of riparian areas, meadows, springs, and seeps in a manner that promotes vegetation structure and composition appropriate to the site. In some cases enclosure fencing may be a viable option. However, in some cases, (e.g., enclosed meadows), the availability and quality of herbaceous species may be improved by periodic grazing use of enclosure and should be considered in the grazing management program.

Issue Addressed	Rationale	Conservation Measure(s)
		3. In agricultural fields where sage-grouse use has been documented or is likely, willing landowners may wish to avoid or limit use of alfalfa by livestock after the last cutting, to provide residual alfalfa for use by sage-grouse broods.
Livestock management during periods of drought.	Drought conditions can intensify the effects of livestock grazing on upland and riparian vegetation.	1. In sage-grouse nesting and brood-rearing habitats, adjust livestock use (season, utilization, stocking, intensity, and/or duration) during drought to minimize the additional stress placed on herbaceous species. This is anticipated to reduce impacts on perennial herbaceous cover, plant species diversity, and plant vigor. 2. Foster the coordination of drought management activities and outreach through the Idaho Rangeland Drought Subcommittee.
Placement of salt and mineral supplements.	The placement of salt and mineral supplements can affect sage-grouse habitat quality.	1. When using salt or mineral supplements: a) place them in existing disturbed sites, areas with reduced sagebrush cover, seedings, or cheatgrass sites (for example) to reduce impacts to sage-grouse breeding habitat, b) where feasible, use salts or mineral supplements to improve management of livestock for the benefit of sage-grouse habitat.
Placement of fences and other structures.	The placement of fences or other structures near important seasonal habitats can increase the risk of collision mortalities or may facilitate predation by eagles, hawks and ravens.	1. Biologists, in cooperation with LWGs and willing landowners, are encouraged to use existing knowledge, allotment/pasture maps and lek distribution maps, to determine which fences may pose the greatest risk for collision mortality. 2. If sage-grouse mortality due to collision with fences is documented, or if collisions are likely to occur due to new fence placement, implement appropriate actions to mitigate impact. Such actions might include marking key sections of fences with permanent flagging or other suitable means. Field personnel and landowners should use their best judgment in determining where fence marking is required to lessen the impacts to sage-grouse. 3. Placement of new fences and structures should include consideration of their impact on sage-grouse. In general, avoid constructing new fences within 1 km (0.6 mi) of occupied leks (adopted from Connelly et al. 2000*b*). Where feasible, place new, taller structures such as corrals, loading facilities, water storage tanks, windmills etc., as far as possible from occupied leks to reduce opportunities for perching raptors. Careful consideration, based on local conditions, should also be given to the placement of new fences or structures near

Issue Addressed	Rationale	Conservation Measure(s)
		other important seasonal habitats (winter-use areas, movement corridors etc.) in order to reduce potential impacts.
Design and placement of water developments.	Water developments can: result in mortality of sage-grouse due to drowning; affect the flow of springs/wet meadows; foster the spread of invasive plants; or encourage grazing or disturbance of previously unused or lightly used breeding or early brood habitat.	1. New spring developments in sage-grouse habitat should be designed to maintain or enhance the free-flowing characteristics of springs and wet meadows by the use of float valves on troughs or other features where feasible. Retrofit existing water developments during normal maintenance activities. 2. Ensure that new and existing livestock troughs and open water storage tanks are fitted with ramps to facilitate the use of and escape from troughs by sage-grouse and other wildlife. Do not use floating boards or similar objects, as these are too unstable and are ineffective. See Wildlife Watering and Escape Ramps on Livestock Water Developments (Sherrets 1989) for suggestions for ramp designs. 3. When placing new water developments in sage-grouse breeding habitat, choose sites and designs that will provide the greatest enhancement for sage-grouse and sage-grouse habitat. 4. Avoid placing water developments into higher quality native breeding/early brood habitats that have not had significant prior grazing use.
Management of livestock during rehabilitation and restoration efforts.	The practicality of extensive rangeland rehabilitation and restoration efforts is dependent upon adequate plant establishment time (rest) before grazing resumes.	1. Identify and when feasible, establish strategically located forage reserves focusing on areas unsuitable for sage-grouse habitat restoration, or lower priority habitat restoration areas. These reserves (such as seedings) would serve to provide livestock operators with temporary alternative forage opportunities during the resting of recently seeded restoration or fire rehabilitation areas and could serve as additional fuel breaks depending on location and configuration[26]. 2. Identify and utilize economic incentive programs to assist private landowners in implementation of appropriate sage-grouse habitat conservation actions on private lands.

[26] This concept may be particularly relevant in portions of Idaho where large-scale restoration efforts are anticipated (e.g., East Magic Valley, Big Desert).

Research, monitoring or evaluation needs: Research is needed to better understand the impacts of livestock management (systems and individual practices) on sage-grouse populations, and habitat. Monitoring and evaluation is also necessary to better identify and determine the impacts of current grazing management practices on sage-grouse populations, and habitat. Document the extent of sage-grouse collision with fences and conduct effectiveness monitoring of flagged or tagged fences.

4.3.5 Human disturbance

4.3.5.1 Threat summary and background

Human disturbance encompasses several distinct issues, for which varying levels of concern have been expressed. Off-highway vehicle (OHV) use has increased dramatically in recent years, and there is considerable concern about the potential for disturbance to sage-grouse on leks or other important seasonal habitats, ground disturbance, spread of invasive plants, and increased fire risk. Military training activities, while they may be necessary in the interest of national defense are nonetheless a potential source of disturbance.

Project construction and maintenance activities near leks are also matters of concern, and encompass a host of activities associated with other potential threats such as infrastructure, mines and gravel pits. Human activities associated with management of cattle or sheep on or near occupied leks may also cause disturbances under some circumstances. Finally, wildlife viewing and photography, while an important aspect of public education and nonconsumptive use, nonetheless can result in disturbance to lekking birds. In general, when humans approach occupied leks, grouse often flush and may or may not return the same day (Call 1979).

4.3.5.2 Summary of key conservation issues

- **Off-highway vehicle (OHV) disturbance:** Off-road vehicles, including four wheel drives, all terrain vehicles (ATV) and motorcycles can potentially disturb sage-grouse activity at leks and threaten other important seasonal habitats (nesting, brood-rearing, fall/winter). Examples of specific impacts include: increased human presence, noise, ground disturbance, spread of weed seeds, direct damage to sagebrush plants and other vegetation, and risk of human-caused wildfire. In some areas, OHVs are used extensively to search cross-country for shed antlers in the spring, and adverse impacts to sage-grouse or sage-grouse habitat are likely. In some areas, mountain biking may also pose a potential disturbance during lekking and nesting periods.

  The use of certain types of OHVs in Idaho is increasing dramatically, statewide (Figure 4-12). Although, some of this increase may be due to improved compliance with registration (Idaho Department of Parks and Recreation 2004). Idaho Department of Parks and Recreation (IDPR) statistics for southwest, southcentral, southeast and eastern Idaho, representing portions of the state most relevant to sage-grouse managers, indicate that motorbike and ATV registrations

overall have nearly doubled between 1999 and 2003 (Figure 4-13). Eastern Idaho exhibited the greatest increase of registrations (141.6%) during that timeframe, followed by southeast (93.2%), south-central (85.6%) and southwest (80.8%).

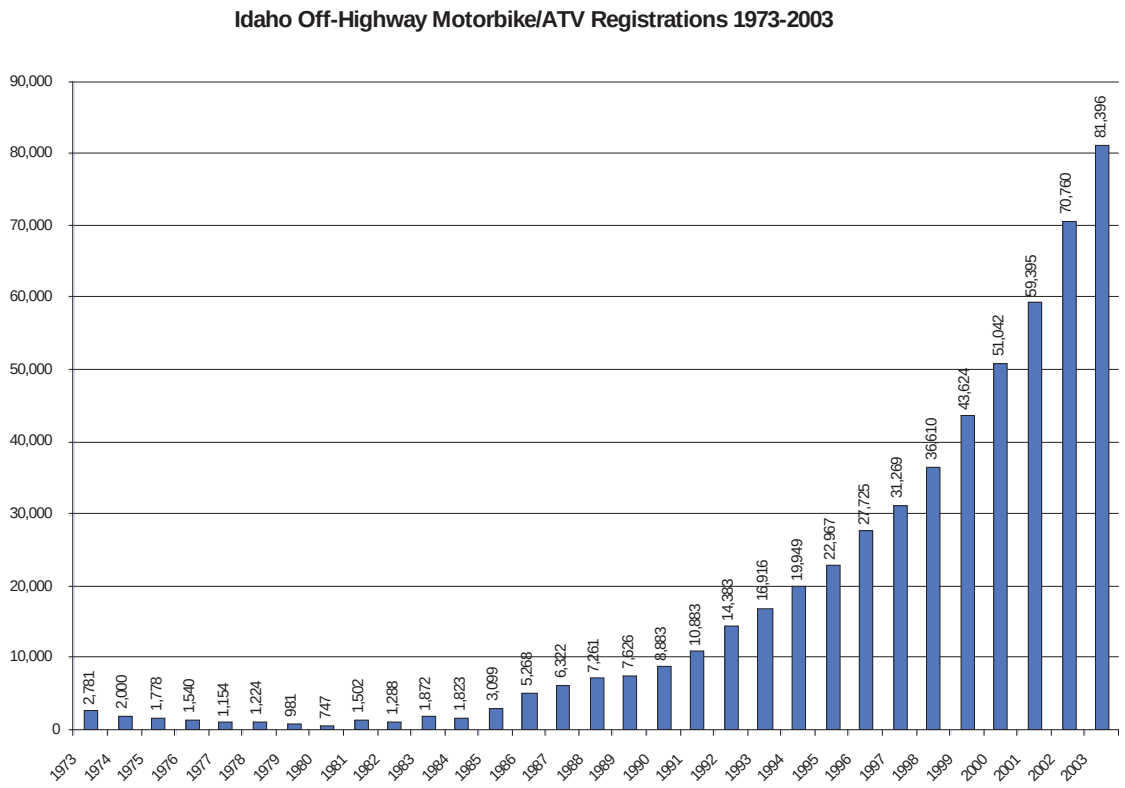


Figure 4-12 Idaho Off-Highway Motorbike/ATV Registrations 1973-2003[27]

[27] Figure courtesy IDPR (2004). Numbers are not definitive, as they reflect only registered motorcycles and ATVs. Additionally, part of the increase may be due to improved compliance with registration.

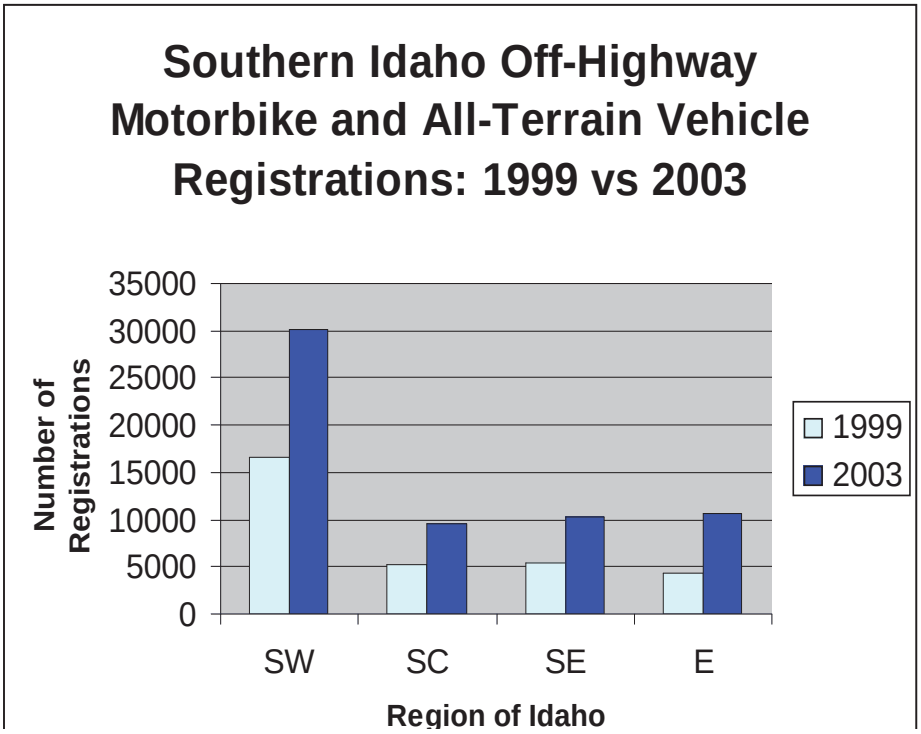


Figure 4-13 Southern Idaho ATV and Off-Highway Motorbike Registrations 1999 VS 2003[28]

- **Military training:** Many military exercises are destructive by their nature (Connelly et al. 2004). Direct impacts result from maneuvers by tracked and wheeled vehicles and from fires originating from ordnance impacts (Connelly et al. 2004). Vehicle disturbance facilitates the spread of exotic plants, increases potential for soil erosion and potentially reduces ecosystem productivity and stability (Belcher and Wilson 1989, Shaw and Diersing 1990, Watts 1998 cited in Connelly et al. 2004). Direct and indirect affects of access roads, noise and human disturbance associated with emitter sites are also of concern.

  Habitat fragmentation and loss of native shrubs on broader spatial scales is also of concern. Knick and Rotenberry (1997) reported that military training activities with tracked vehicles was associated with a landscape characterized by small, closely spaced shrub patches.

[28] SW=Southwestern Idaho, SC=Southcentral Idaho, SE=Southeastern Idaho, E=Eastern Idaho. Southern Idaho data summarized from IDPR (2004). Numbers are not definitive, as they reflect only registered motorcycles and ATVs. Additionally, part of the increase may be due to improved compliance with registration.

In 2004, an Integrated Resources Management Plan (IRMP) was completed for the Mountain Home Air Force Base including affiliated training ranges (U.S. Air Force 2004). The IRMP, in part, addresses fish and wildlife management issues related to Mountain Home Air Force Base and affiliated training ranges including Saylor Creek, Juniper Butte and other sites. Goals include the restoration and enhancement of wildlife habitats to increase biological diversity and to avoid disturbance to special status species. Specific objectives, depending on the site, include the seeding of sagebrush and native species where practical, restoration of native or fire-resistant vegetation, control of fine fuels and weeds, fire prevention and management, off-road restrictions, consideration of seasonal restrictions and awareness training for training range users. The IRMP also commits to continued coordination with the Owyhee sage-grouse LWG. Progress is reported during annual meetings with IDFG and other cooperators.

- **Project and maintenance activity near leks:** Construction and maintenance activities associated with rangeland improvements, vegetation manipulation projects; roads, gas/oil pipelines, utilities and communication structures (see also Infrastructure 4.3.2), and other similar activities near occupied leks during the breeding season have the potential to disturb sage-grouse. The significance of the threat is a function of proximity, timing, and duration of the activity. The current level of disturbance and impacts of these factors on Idaho sage-grouse populations are unknown, but in many cases, can likely be reduced or minimized. Suggested buffers vary. Connelly et al. (2000*b*), in the context of human disturbance associated with energy exploration, recommended minimizing human activities within view of or <0.5 km (0.3 miles) of active leks. Stinson et al. (2004) and Utah Division of Wildlife Resources (2002) recommend a 1 km buffer.

- **Human activity associated with management of livestock:** Human activities associated with livestock management (e.g., fence construction, sheep camps, etc.), near sage-grouse leks have the potential to disturb lek activity or hens nesting in the vicinity of leks (see also Infrastructure 4.3.2 and Livestock Impacts 4.3.4).

- **Wildlife viewing/photography at leks:** The viewing and photography of sage-grouse at leks is an interest pursued by a relatively small, but in all likelihood, growing number of enthusiasts. Instances of photographers camping on leks have been noted, as has the presence of temporary blinds. Such activities disturb breeding sage-grouse. Viewing from automobiles does not appear to disrupt courtship activity, but grouse flush when people leave cars to get a closer look (Stinson et al. 2004).

4.3.5.3 Human disturbance conservation measures

Goal: To eliminate, reduce or minimize human-related disturbance to sage-grouse on important seasonal habitats.

Issue Addressed	Rationale	Conservation Measure(s)
OHV disturbance	OHV activity can disturb sage-grouse, adversely impact vegetation and soils, and increase fire risk.	1. Limit OHV use to existing designated roads and trails to eliminate or minimize disturbance to sage-grouse and reduce the risk of wildfire and other habitat disturbances associated with cross-country travel. Consider a "closed unless posted open" approach where appropriate. 2. Discourage the creation of new roads and trails in sage-grouse breeding or winter habitat. Re-route existing trails and route new trails in a manner that minimizes disturbance. 3. Where existing roads or OHV trails are near occupied leks, apply use-restrictions where needed and appropriate, to minimize nonessential activity between 6:00 PM to 9:00 AM. In general this guideline should be applied from approximately March 15 through May 1 in lower elevation habitats and March 25 through May 15 in higher elevation habitats, where OHV or vehicular disturbance is a problem. 4. Work collaboratively with OHV user groups to increase awareness of the potential adverse impacts of OHVs on sage-grouse and other wildlife and to develop solutions to reduce conflict.
Military training	Military training activities can disrupt sage-grouse, lead to fires and habitat fragmentation, increase invasives and human disturbance.	1. Continue cooperating with the military (e.g., Mountain Home Air Force Base Integrated Resources Management Plan) in designing and improving measures to reduce or mitigate the effects of military training activities on sage-grouse and sage-grouse habitat. 2. Foster further communication and collaboration between the military, land management agencies and landowners via the Idaho Sage-grouse Advisory Committee and Local Working Groups. Utilize such partnerships to more effectively plan resource management and protection activities on a landscape basis.
Projects and maintenance activity near leks	Human disturbance can cause disruption of breeding or nesting sage-	1. Human activities such as fence and pipeline maintenance or construction, facility maintenance, utility maintenance, or any project or related work at or near (1 km or 0.6 miles) occupied leks that results in or will likely result in disturbance to lekking birds should be

	grouse.	avoided from approximately 6:00 PM to 9:00 AM. In general this guideline should be applied from approximately March 15 through May 1 in lower elevation habitats and March 25 through May 15 in higher elevation habitats.
Human activity associated with management of livestock	Human activities associated with livestock management near sage-grouse leks has the potential to disturb lek activity or hens nesting in the vicinity of leks	1. Avoid creating unnecessary disturbances related to livestock management activities near occupied leks whenever possible (see also Livestock Impacts Section 4.3.4). 2. Sheep camps and related issues. Please see Livestock management and leks Conservation Measure No. 1 in the Livestock Impacts section.
Wildlife appreciation, viewing, and photography at leks	Careless or imprudent activities associated with viewing of sage-grouse at leks can lead to disturbance of breeding sage-grouse.	1. Wildlife viewing and appreciation should be promoted; however, the viewing of sage-grouse on leks should be conducted so that disturbance to birds is minimized or eliminated. Use of blinds for photography at leks should be limited to the latter part of the lekking season, outside of peak breeding activity, as determined locally. 2. Where photography or viewing activities appear to be increasing in extent, or if they appear to be problematic in certain areas, consider designating 1-3 lek locations for public viewing. Other alternatives might include establishing one or more seasonal blinds for public use, utilize agency staff or trained volunteers to guide viewers to selected leks during designated times, and limit close-up viewing/photography of selected leks to the latter portion of the breeding season after most breeding has occurred. 3. Camping on occupied leks should not be allowed, to eliminate sustained disturbance. 4. Improve the dissemination of information to elementary and high school students, hunters, resource user-groups, and others to increase their understanding of sage-grouse and sagebrush steppe conservation issues. 5. Monitoring of leks should be done in a manner that minimizes disturbance to sage-grouse. Follow the established protocol described in Section 5.2.1.1 and 5.2.1.2.

Research, monitoring or evaluation needs: Evaluation is needed to document areas where general recreation, and especially OHV activity may be causing unacceptable disturbances to leks or damage to important seasonal habitats and to aid in the planning or zoning of trails and closure restrictions. Coordination with the Rangewide Conservation Strategy team in developing or refining suggested disturbance buffers is recommended. In addition, there is a need to identify and map areas where potential conflicts may be occurring with human activities related to sheep bedding and leks.

4.3.6 West Nile Virus

4.3.6.1 Threat summary and background

Between 1999 and 2005, 284 species of birds were reported to the Centers for Disease Control and Prevention (CDC) West Nile Virus (WNV) avian mortality database including greater sage-grouse (Centers for Disease Control and Prevention 2005). The disease appears to be spread primarily by mosquitoes (see detailed discussion in Connelly et al. 2004). The virus was first documented on the east coast of the United States in 1999 and has rapidly spread westward (Naugle et al. 2004*a*). Water that persists into late summer in dry landscapes may attract sage-grouse and expose them to insects that carry WNV, however the role that natural and human-constructed water sources play in the spread of WNV is unclear (Walker et al. 2004, Naugle at al. 2004*b*). Monitoring of radioed sage-grouse was initiated in Wyoming and Montana in 2004 to quantify the relationship between various surface water sources and WNV vectors (Walker et al. 2004).

Infected birds in the field often show a lack of mobility, tilted or drooping head or drooping wings when roosting, or weak flight when flushed (Walker et al. 2004). WNV represents a significant new stressor on sage-grouse and probably other at-risk species (Naugle et al. 2004*a*).

In greater sage-grouse, WNV was first detected in northeast Wyoming, eastern Montana, and southeast Alberta in summer 2003 (Naugle 2004*a*). In 2003 WNV reduced late-summer survival an average of 25% in four radio-marked populations in Wyoming, Montana and Alberta, Canada (Naugle et al. 2004*a*). Late summer survival of radio-marked female sage-grouse in the Powder River Basin of Wyoming and Montana was 76% in two sites without WNV but was only 20% at a site with confirmed WNV mortalities (Walker et al. 2004). Most sage-grouse do not appear to be able to survive WNV infection or develop immunity (Naugle et al. 2004*b*). However, the Wyoming State Veterinary Laboratory recently confirmed that 10% (5 of 50) of blood samples from female greater sage-grouse collected in the Powder River Basin tested positive for antibodies to WNV (D. Naugle, personal communication 8/31/05; Casper Star-Tribune 8/25/2005).

In Idaho, the first probable human case was reported in November 2003 (Idaho Department of Health and Welfare 2005). In August 2004, the first infected bird, a magpie from Gooding County, tested positive (Idaho Department of Health and Welfare 2004). Infected sage-grouse had not been detected in Idaho as of July 2005. (For additional information see http://www.westnile.idaho.gov).

Continued surveillance for WNV is in progress. Instructions for the handling and transport of bird carcasses for subsequent WNV testing have been provided to IDFG regions and other agencies.

4.3.6.2 Summary of key conservation issues

At present, given that there is little that can be done once sage-grouse have contracted WNV, the key conservation issues involve detection and research.

- **Need for continued surveillance for WNV:** Early detection of WNV in sage-grouse can help managers better assess risk and determine further actions (e.g., alert the public, restrict seasons, increase monitoring).

- **Need for better information concerning land management activities that reduce risk of transmission:** The effects of land management activities on WNV and its vectors is largely unknown

4.3.6.3 West Nile Virus conservation measures

Goal: Ensure that WNV is detected as early as possible.

Issue Addressed	Rationale	Conservation Measure(s)
Need for continued surveillance for WNV	Early detection of WNV in sage-grouse can help managers better assess risk and determine further actions (e.g., alert the public, restrict seasons, increase monitoring).	1. Continue cooperating with regional and state-level WNV monitoring and/or surveillance efforts.
Need for better information concerning land management activities that reduce risk of transmission	The effects of land management activities on WNV and its vectors is largely unknown	1. Cooperate with research efforts to evaluate habitat conditions that contribute to WNV and conservation measures to reduce risk. 2. Identify effective conservation measures to manage potential WNV vectors.

Research, monitoring or evaluation needs: Continued testing for immunity. Research and testing of potential conservation measures.

4.3.7 Prescribed fire

4.3.7.1 Threat summary and background

In this section, the discussion of prescribed fire and related conservation measures also encompasses other "sagebrush control" activities, such as mechanical treatments. To minimize redundancy in this plan, the choice was made to combine these discussions because: (1) certain issues related to the effects of prescribed fire and other sagebrush control techniques may be similar, such as habitat reduction and risk of invasives, and (2) management objectives may be similar. Combining the discussions, however, is not intended to imply that the risk of mechanical sagebrush control is the same as that of prescribed fire.

Prescribed fire can be used to control annual grasses, reduce sagebrush density, facilitate growth of grasses and forbs, and control juniper and pinyon expansion into sagebrush habitats (Connelly et al. 2004). For example, it can be an effective tool in reducing mountain big sagebrush cover and density and increasing herbaceous productivity on more mesic rangelands, and in reducing heavier fuel loadings in certain strategic areas. Prescribed fire may be an appropriate and necessary site-preparation technique in the restoration of poor quality habitat. For example, in cases where the removal of cheatgrass thatch is needed prior to chemical treatments and seeding; or in specific circumstances where the temporary removal of sagebrush cover (excluding winter range) is needed to facilitate drill-seeding during restoration operations. Prescribed fire is also a potential tool for maintaining forage reserves that provide alternative livestock foraging areas during restoration efforts; it may also be used in maintaining certain grass seedings that were installed previously, to help offset grazing impacts to native rangelands or riparian areas.

However, prescribed burning of sagebrush habitats also involves risk. Prescribed fires can escape under certain conditions, affecting areas beyond the planned treatment area. The recovery of burns in drier sites can be very slow, and the limited viability of sagebrush seed limits regeneration if post-burn weather conditions are unfavorable (Connelly et al. 2004). After a nine-year study on Idaho's Big Desert, Connelly et al. (1994, 2000*c*) reported that prescribed burning of Wyoming big sagebrush during a drought period resulted in a large decline of a sage-grouse breeding population. In a study of twenty wildfires and prescribed fires in eastern Idaho, Nelle et al. (2000) reported mean canopy cover for mountain big sagebrush 14 years post-burn was less than half that of the unburned sites (8% vs. 18%). However, the character and scale of the burn mosaic, fire severity, spring precipitation and other factors may influence the recovery of sagebrush canopy cover to levels suitable for nesting habitat. In general, prescribed burn programs in mountain big sagebrush

should be planned to avoid creating a landscape of adjacent young burns (Nelle et al. 2000). For additional discussion of the effects of fire on sagebrush and/or sage-grouse, see the Wildfire section 4.3.1, and Chapter 2, Sagebrush Ecology.

Prescribed fire acreages and associated details are difficult to summarize statewide, due to agency variations in project documentation methods and lack of centralized reporting. Some coarse data are available however: BLM Public Land Statistics reported 93,724 acres of prescribed fire occurred on Idaho BLM lands between 1997 and 2002.[29] While annual acreages of prescribed fire are reported across 7 categories including forestry, range, wildlife, hazard reduction, watershed, ecosystem health, and other, it is impossible to infer from this data the extent to which prescribed burns may have had adverse impacts, or provided benefits, to sage-grouse.

Other techniques are also often used to manage vegetation, such as mowing, brush beating, chaining, harrow, and herbicides. However, due to differences in project documentation procedures and a lack of centralized reporting, acreages by vegetation type are not readily available. BLM Public Land Statistics 1999-2002[30] indicate that from 1999 (the first year data were reported in this manner) through 2002, approximately 209,628 acres of "non-fire fuels treatments" occurred on Idaho BLM Lands.

To effectively monitor the spatial and temporal extent of prescribed fire and other vegetation treatments as related to sage-grouse habitats, there is a pressing need for more consistent and detailed project reporting, across all agency jurisdictions. See Chapter 5.3 for discussion of processes for consolidating project reporting across Idaho.

4.3.7.2 Summary of key conservation issues

Prescribed fire and other sagebrush control activities can pose a risk to sage-grouse if projects are planned without the appropriate consideration for fine-, mid-, and broad-scale habitat conditions on the landscape and cumulative effects over time. In the context of this Plan, the primary threats from prescribed fire are (1) the elimination or reduction of sagebrush cover in situations where breeding or winter habitat may be already limited or fragmented on the landscape, and (2) risk of expansion by invasive plant species. In general, there is more treatment flexibility in situations where breeding or winter habitats are extensive on the landscape; invasives are uncommon

[29] Prescribed fire and non-fire fuels data as reported in PLS are not available beyond 2002.

[30] 1999 was the first year non-fire fuels treatment acreages were reported in PLS.

or are controllable; or in more resilient, higher elevation, mesic landscapes used primarily as late brood habitat.

- **Reduction of already limited or fragmented habitat**: While prescribed burns and other sagebrush management treatments have potentially beneficial outcomes, there is some risk that in certain situations, prescribed burn projects might adversely affect breeding or winter habitat. For example, Connelly et al. (2004) suggested that the recovery of sagebrush canopy cover to pre-burn levels may require 20 years or longer in some areas, and expressed concerns that short-term benefits such as increased forb production may not balance the loss of sagebrush canopy required during the nesting or winter seasons. Crawford et al. (2004) suggested that prescribed burning of sagebrush should not be used if sagebrush cover is a limiting factor for sage-grouse in the area. In all cases, vegetation management projects should be carefully planned [illegible] ***erat*** [illegible] ***the*** [illegible] ***rr*** [illegible] ***a*** [illegible] ***ape***, and with an understanding of which seasonal sage-grouse habitats may be limited locally or in poor ecological health.

- **Expansion of exotic plant species:** Prescribed fire and sagebrush management treatments can pose a risk to sage-grouse if applied in areas prone to proliferation of exotic annuals (Connelly et al. 2000*b*). In such cases, provision must be made for the control of the invasive plant species and for the establishment of desirable perennial herbaceous species (Connelly et al. 2000*b*).

- **Risk of escaped prescribed fire**: Escaped prescribed fires pose a risk to adjoining seasonal habitats in suitable condition (meeting seasonal habitat criteria), and therefore may compound concerns about habitat availability.

4.3.7.3 Prescribed fire conservation measures

While the following list of conservation measures is focused most specifically on prescribed fire, the identified measures are also intended to address other sagebrush control conservation issues.

Goal: Plan and carry out prescribed burns and other sagebrush management projects in a manner that promotes ecosystem health and sustainability and that ensures the retention of sagebrush cover on a scale sufficient to meet the seasonal habitat needs of sage-grouse populations. Private landowners are encouraged to work closely with IDFG, NRCS, adjacent landowners and other partners, as appropriate.

Issue Addressed	Rationale	Conservation Measure(s)
Reduction of already limited or fragmented habitat	Inadequate planning and implementation of prescribed burns, or other sagebrush treatment projects, may adversely impact sage-grouse seasonal habitats and/or sage-grouse populations.	1. Prior to planning prescribed burns, or other vegetation management treatments in sagebrush communities, ensure that sage-grouse seasonal habitats have been mapped (see 5.3.2 for additional discussion of mapping). 2. Once seasonal habitats have been mapped, ensure that proposed project areas have been evaluated on the ground in the context of the appropriate seasonal habitat characteristics.(See 5.3.2). 3. Avoid the use of prescribed fire, and other sagebrush reduction projects, in habitats that currently meet or are trending toward meeting breeding or winter habitat characteristics or in areas where sagebrush is limiting on the landscape. 4. If the analysis shows that a vegetation treatment may still be advisable, design habitat manipulation projects to achieve the desired objectives, considering the following: A. Where prescribed burning, or other treatments, in sage-grouse habitats may be warranted (e.g., sagebrush cover exceeds desired breeding or winter habitat characteristics; understory does not meet seasonal habitat characteristics and restoration is desired; there is a need to restore ecological processes; or a proposed treatment site is in an exotic seeding being managed for overall sage-grouse benefits on the surrounding landscape): ▪ Project design should be done with interdisciplinary input, and in cooperation with IDFG. ▪ Ensure that any proposed sagebrush treatment acreage is conservative in the context of surrounding seasonal habitats and landscape. ▪ Where appropriate, ensure that treatments are configured in a manner that promotes use by sage-grouse (see Connelly 2000 for additional discussion). ▪ Leave adequate untreated sagebrush areas for loafing/hiding cover near leks for sage-grouse. 4. Evaluate and monitor prescribed burns, and other treatments, as soon as possible after treatment and periodically thereafter to determine whether the project

Issue Addressed	Rationale	Conservation Measure(s)
		was successful and is meeting or trending toward desired objectives.
Expansion of exotic plant species	Inadequate planning, implementation and follow-up of prescribed burns or other sagebrush treatments may result in the expansion of cheatgrass or other invasive plant species.	1. Avoid the use of prescribed fire or other sagebrush treatments in habitats prone to the expansion or invasion of cheatgrass or other invasives unless adequate measures are taken to control the invasives and ensure subsequent dominance by desirable perennial species. In many if not most cases, this will likely require chemical treatments and reseeding.
Risk of escaped prescribed fire	Escaped prescribed fires can threaten surrounding habitats.	1. Prescribed fires must be planned, executed and monitored in a manner that provides for adequate control and provision for contingency resources. 2. Ensure burn plans address the importance of preventing escaped fires when prescription fires are planned in the vicinity of stronghold and key habitat.

Research, monitoring or evaluation needs: There is need for a more effective and consistent approach for the periodic mapping and classification of sagebrush habitats and cover classes using remote imagery. Research sage-grouse response to prescribed fire in the Mountain Big Sagebrush ecosystem.

4.3.8 Seeded perennial grassland

4.3.8.1 Threat summary and background

While of moderate risk individually, the link of perennial grasslands with other threats such as wildfire (and subsequent burned area rehabilitation), or annual grasslands (and restoration activities) suggest that its influence or significance as a threat may be more complex.

Native perennial grasslands can serve as a foundation for future sage-grouse habitat and are a normal, temporary result of wildfire in healthy sagebrush ecosystems. Seeded perennial grasslands can serve various purposes including as an intermediate treatment during the restoration of annual grasslands. Sage-grouse are known to use small patches or strips of seeded perennial grassland if adjacent to or surrounded by sagebrush. However, since sage-grouse are dependent on sagebrush, extensive areas of exotic and/or mixed seeded perennial grasslands can pose a threat to sage-grouse due to a lack of adequate sagebrush cover to meet seasonal habitat requirements. Seeded perennial grasslands characterized by aggressive, introduced grasses, such as crested wheatgrass, can also be limited in plant species diversity and structure. For a detailed discussion on this subject, see Pellant and Lysne (2005). The natural post-fire recovery of sagebrush in large grasslands can also be hindered if sagebrush seed-sources are limited. Without deliberate intervention to improve plant species diversity and structure, some large, seeded grasslands are unlikely to support habitat characteristics suitable for sage-grouse within a reasonable management timeframe.

In general, seeded perennial grassland areas in southern Idaho have been established for purposes of watershed stabilization following large rangeland wildfires; to provide competition from weeds such as *Halogeton*; and to provide improved livestock forage in some areas. More recently, efforts have been initiated to restore degraded areas with more diverse native and/or introduced perennial grass and forb mixtures in order to replace hazardous fuels, such as cheatgrass, and improve rangeland health and wildlife habitat. In the past introduced perennial grasses (e.g., crested wheatgrass) were often planted due to low cost and high likelihood of seeding success. They were also selected due to limited quantities of suitable native species, however, the availability and supply of these has increased in recent years. Recent policy changes and initiatives have also fostered the use of native species. Specifically, Presidential Executive Order 13112 on Invasive Species (Clinton 1999) directs Federal Agencies to use native species where feasible, and BLM's Great Basin Restoration Initiative favors the use of native species, "pending seed availability, cost and chance for success"(USDI-BLM 2000b). Regardless of the origin, large seeded grasslands with low plant species diversity, and/or sustained lack of sagebrush cover are not

compatible with the recovery of sage-grouse, and diversification efforts are warranted in some areas.

4.3.8.2 Summary of key conservation issues

- **Spatial extent of perennial grasslands on the landscape:** The extent of perennial grasslands in Idaho varies by SGPA (Figure 4-14). It is difficult at this time to spatially differentiate between true native grasslands, seeded native, seeded introduced or mixed native/introduced grasslands without more intensive mapping and ground-truthing efforts, or detailed review of agency project records. As mapping technologies and field inventory efforts improve, additional mapping refinements will be incorporated. The new ShrubMap regional landcover dataset (http://sagemap.wr.usgs.gov/) may be useful in preliminarily delineating annual and perennial grasslands.

  Broad-scale spatial analysis of the 2004 Idaho Sage-grouse Habitat Planning Map indicates that perennial grasslands (all types combined) comprise approximately 2,933,439 acres within Idaho SGPAs (Table 4-11). The most extensive grasslands are associated with SGPAs in south-central Idaho including the Big Desert, East Magic Valley, West Magic Valley, and Jarbidge. Most current perennial grasslands are administered by the BLM but private, state, and Department of Energy lands harbor relatively substantial acreages as well (Table 4-11).

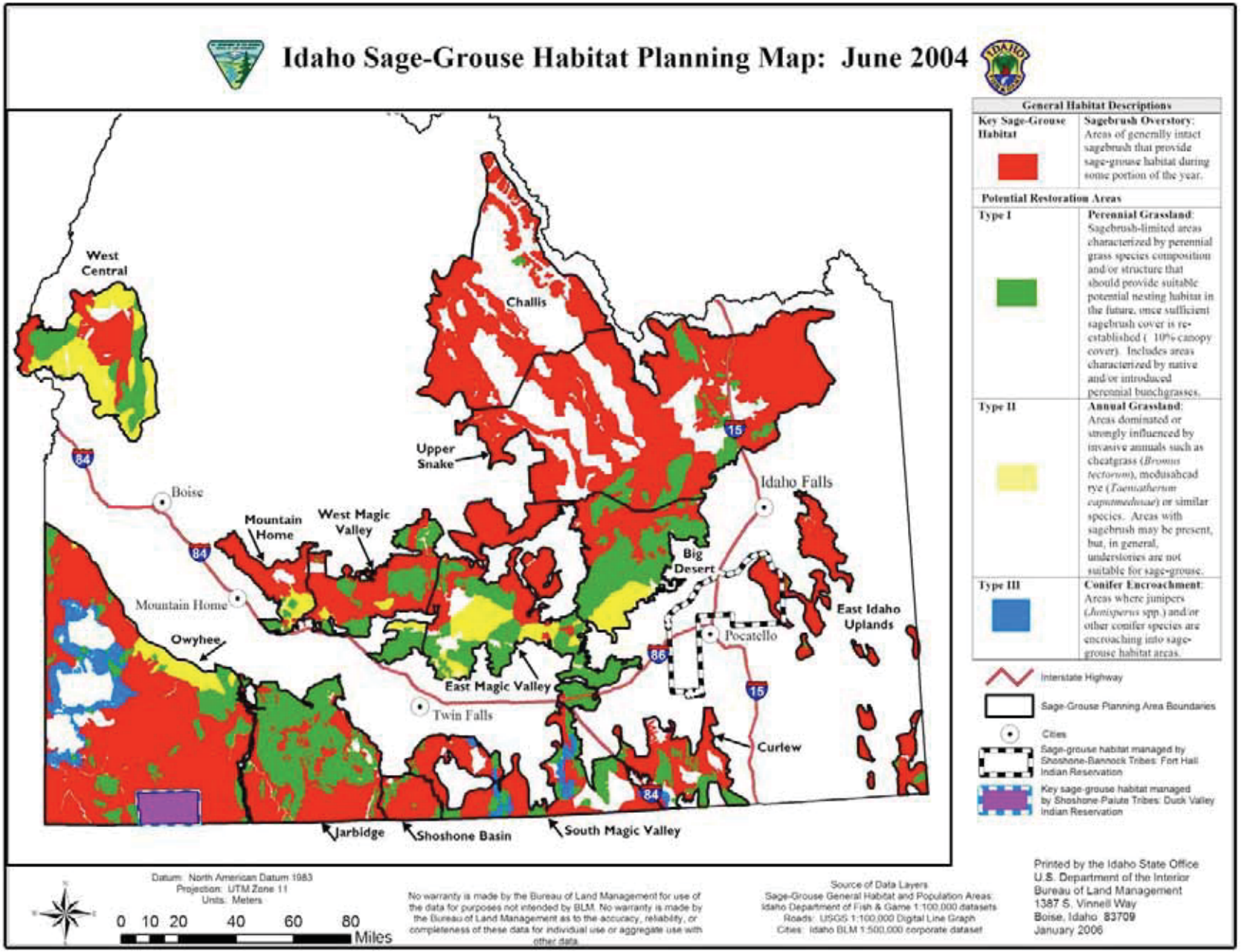


Figure 4-14 Idaho Sage-grouse Habitat Planning Map. Green areas indicate perennial grasslands.

Table 4-11 Perennial grasslands by Idaho Sage-grouse Planning Area and land-ownership status (USDI-BLM 2004*a*).

	Land-ownership status[31]										
SGPA	**BLM**	**BLM NM**	**BIA**	**USFS**	**DOE**	**MIL**	**NPS**	**Private**	**IDL**	**USFWS**	**Total**
Big Desert	281,747	44,951	0	0	25,224	0	1,038	20,552	56,828	0	430,340
Challis	4,519	0	0	34	0	0	0	979	47	0	5,579
Curlew	53,775	0	0	7,466	0	0	0	39,354	2,087	0	102,682
East Idaho Uplands	5,928	0	2,246	0	0	0	0	6,927	719	2	15,822
East Magic Valley	399,026	34,609	0	0	0	0	1,933	37,912	19,886	10,551	503,917
Jarbidge	524,267	0	0	0	0	26,046	0	27,273	31,077	0	608,663
Mountain Home	21,012	0	0	0	0	0	0	7,191	396	0	28,599
Owyhee	274,294	0	0	0	0	5	0	9,795	15,800	0	299,894
Shoshone Basin	10,698	0	0	42	0	0	0	11,078	2,062	0	23,880
South Magic Valley	102,540	0	0	24,955	0	0	1,064	46,227	7,348	0	182,134
Upper Snake	84,804	0	0	1,078	113,936	0	0	27,197	6,105	8,131	241,251
West Central	103,408	0	0	1,015	0	0	0	95,009	15,511	0	214,943
West Magic Valley	214,520	0	0	0	0	0	0	39,087	22,128	0	275,735
Total	**2,080,538**	**79,560**	**2,246**	**34,590**	**139,160**	**26,051**	**4,035**	**368,581**	**179,994**	**18,684**	**2,933,439**

[31] BLM: Bureau of Land Management; BLM NM: BLM-administered lands associated with Craters of the Moon National Monument; BIA: Bureau of Indian Affairs; USFS: U.S. Forest Service; DOE: Department of Energy, INEEL; MIL: Military; NPS: National Park Service; IDL: Idaho Department of Lands; USFWS: U.S. Fish and Wildlife Service. Acreages are approximate only and are reflective of the relatively broad nature of the 2004 SGHPM.

- **Reduced species diversity and structure:** At the finer more site-specific scale, some seeded perennial grasslands, aside from lacking in sagebrush cover, also may be deficient in plant species diversity and structure. Substantial acreages of Idaho BLM lands burned by wildfire have been aerially reseeded with sagebrush in recent years, and the use of native grass species in fire rehabilitation seedings and restoration projects is being emphasized where possible. Some successes have been noted. However, Dalzell (2004) in a study of 35 fire rehabilitation projects on the Snake River Plain, found no significant differences in species composition of seeded and unseeded burn plots, though cover of introduced species on unseeded plots was likely an artifact of older seeding efforts. Dalzell (2004) also reported poor establishment of Wyoming big sagebrush via aerial seeding, and suggested alternative approaches. Sagebrush and native grass restoration efforts can be problematic and are contingent on numerous factors including site potential, short-term climatic conditions, application techniques, competition from invasives, past seeding activities, reoccurring wildfires, and other factors. There is a continuing need for improved documentation, monitoring and reporting of restoration projects to facilitate information transfer and adaptive management.

  The diversification of large, seeded grasslands to a structural and compositional state that contributes to sage-grouse conservation requires a long-term commitment. Several research projects underway in conjunction with the Great Basin Restoration Initiative will contribute to a better understanding of how to restore diverse, functional rangelands. Projects include the Great Basin Native Plant Selection and Increase Project; Coordinated Intermountain Restoration Project, Integrating Weed Control and Restoration for Great Basin Rangelands Project; and A Regional Experiment to Evaluate Effects of Fire and Fire Surrogate Treatments in the Sagebrush Biome.

4.3.8.3 Seeded perennial grassland conservation measures

Goal: To restore sagebrush and/or native grasses and forbs in seeded large perennial grasslands.

Issue Addressed	Rationale	Conservation Measure(s)
All	Lack of sagebrush on the landscape and lack of plant species diversity hinders the recovery of sage-grouse.	1. LWGs, land management agencies, IDFG and other partners should work closely together to identify and prioritize perennial grasslands (exotic versus native) where plant species diversity or sagebrush is limiting on the landscape; and work cooperatively to identify options, schedules and funding opportunities for re-establishing sagebrush in higher priority areas.

Issue Addressed	Rationale	Conservation Measure(s)
		2. When seeding sagebrush, use source-identified, tested seed adapted to local conditions. 3. Consider using one or more of the following approaches for restoring sagebrush to improve likelihood of success (see Dalzell 2004 and Monsen et al. 2004): A. Use of the "Oyer" compact row seeder, which compacts soil and presses seed onto the surface. B. Use of the Brillion cultipacker seeder, where seed is broadcast over the surface followed by cultipacking. C. Transplant bare-root or containerized stock in small, critical areas to establish a seed source. D. Use the "mother plant" technique, and transplant bare-root or containerized stock in select locations throughout the area to establish a seed source. E. For large areas (e.g., large wildland fires) aerial seed onto a rough seedbed (Monsen et al. 2004) coupled with one or more of the above options. 4. In established stands of introduced perennial grasses, transplant sagebrush into strategic patches or strips in critical sites or throughout the area. Scalp spots or strips to reduce grass competition prior to planting or as an alternative to scalps, consider the use of herbicides (see Monsen et al. 2004, Volume 3). 5. Where the diversification of crested wheatgrass or similar seedings with native species of grasses, forbs and/or shrubs is desired Pellant and Lysne (2005) recommend a 3-step process: A. Reduce competition of crested wheatgrass to facilitate the establishment and persistence of the desired species. Possibilities include use of livestock, capitalizing on drought episodes that reduce grass vigor, herbicides such as glyphosate, and mechanical treatments. B. Introduce desired, site-adapted species through drill seeding, aerial seeding followed by

Issue Addressed	Rationale	Conservation Measure(s)
		harrow, cultipacker or chaining, livestock trampling, transplanting container stock, bare-root stock or individual plants from native sources ("wildings"). Lambert (2005) provides descriptions, recommended seeding rates, and other useful information for nearly 250 species of native and non-native grasses, forbs and shrubs. C. Post-treatment management. Ensure that livestock grazing and rest intervals are matched with the phenology and life history characteristics of the desired/ seeded/ transplanted species. Implement monitoring to clearly document how, what, when and where treatments were implemented. Follow up with suitable effectiveness monitoring, to document success of the treatments relative to project objectives. 6. Private landowners may wish to enroll in NRCS incentive programs as related to sage-grouse/sagebrush habitats. Current NRCS programs that may provide some opportunities for economic offset of certain conservation measures include the CSP, WHIP, and EQIP programs. Landowners are encouraged to discuss the various opportunities available with their local NRCS district conservationist and the EQIP Local Working Group. Another potential source of project funding for private lands are Idaho Office of Species Conservation project grants. Landowners interested in OSC grants are encouraged to work through their respective LWG or in the absence of an LWG, the appropriate IDFG Regional Office. Support for Idaho projects may also be available through the North American Grouse Partnership's (NAGP) Grouse Habitat Restoration Fund. Interested parties should contact Mr. Kent Christopher at (208) 356-0079 or grouse@fretel.com.

Research, monitoring or evaluation needs: Cooperate with the Great Basin Restoration Initiative research projects. Develop a consistent approach for monitoring, evaluating and reporting restoration efforts.

4.3.9 Climate change

4.3.9.1 Threat summary and background

The Society for Range Management recently published an issue paper titled *Rangelands and Global Change* (Brown et al. 2005; see http://www.rangelands.org/publications_brochures.shtml). The authors define "global change" as "*any change in the global environment that may alter the capacity of the Earth to sustain life.*" While global change has been occurring since the beginning of time, there is concern with changes attributable to growth in human populations and their use of natural resources (Brown et al. 2005). For example, atmospheric carbon dioxide concentrations may have increased by about 30% due to human activities the past 200 years (Polley 1997). As a result of this, potential changes in land use and productivity, atmospheric chemistry, water resources, ecological systems and climate are of concern.

The impacts of climate change in the context of this plan involve changes in the atmospheric chemistry, long-term temperature and precipitation, and water resources. It must be recognized, however, that while the evidence for human-induced climate change at the global level is increasing, it remains difficult to credibly predict specifically how climate change will impact any particular area (Brown et al. 2005). Climatic variability such as the frequency and severity of extreme events (e.g., droughts, severe rain events, floods, etc.) is likely to increase resulting in both positive and negative effects on the environment. Suring et al. (2005) estimated that over 4.2 million acres (1.7 million ha) of sagebrush cover types in the eastern Great Basin are at high risk of displacement by pinyon-juniper within the next 30 years. Modeling of projected vegetation distribution under seven climate change scenarios suggests decreases in shrubland area in the west during the next century, including a shift from shrubs toward savanna in the Great Basin (Bachelet et al. 2001). Some researchers suggest that sagebrush communities are projected to greatly decrease in area in the lower 48 states, or disappear altogether (Hansen et al. 2001). Additional information can be found at http://www.fs.fed.us/pnw/corvallis/mdr/mapss/.

Climate change is closely interrelated and synergistic with other important threats including wildfire and annual grasslands. Increased climatic variability may result in overall degradation of rangeland conditions and impairment of the ecosystem's elasticity. Rangeland ecosystems are increasingly under threat from weeds, both exotic and native. Increases in invasive exotic species such as cheatgrass, medusahead rye, red brome, knapweed, leafy spurge, yellow starthistle, and woody native species such as juniper, has dramatically reduced the productivity of rangelands by garnering more of the limited resources like water, nutrients and

sunlight. Changes in land use and productivity frequently represent irreversible changes in ecosystem function on human time scales (Brown et al. 2005.)

Climate change impacts on community dynamics and health on rangelands may be magnified compared to other ecosystems due to the aridity and lower resiliency of these lands. Since climate change effects may be greater in these more arid landscapes, close analysis of management and restoration strategies used in the present is advisable, in order to be better prepared to meet potential climate related changes in the future (Mike Pellant, personal communication, July 2005). The response of rangeland vegetation to impending changes in the precipitation regime is likely to be complex and difficult to predict from existing knowledge. Plant response is likely to be highly species-specific, which suggests that current plant communities will not simply move to new landscape positions, but will be replaced by novel plant assemblages (Brown et al. 2005). Increased CO_2 in the atmosphere will favor cool season plants relative to warm season plants. Recent research has demonstrated that cheatgrass may respond more favorably to increased carbon dioxide (CO_2) than do some native plants (Smith et al. 2006) and that recent increases in CO_2 may already have increased cheatgrass production, increasing fuel loads and wildfires (Ziska et al. 2005).

The key to managing rangelands successfully in a changing global environment is maintaining and enhancing ecosystem resilience. Resilience is that property of an ecosystem that defines how well it can recover after disturbance or stress. Rangelands should be managed at the landscape and ecosystem level as well as at the SGPA or watershed scale. Many of the impacts of global change will be expressed unevenly across the landscape, but will be the result of processes and changes that accumulate over time periods and over large scales. Rangelands should also be managed to avoid catastrophic changes. Many of the rangelands in the western U.S. exhibit nonequilibrium dynamics and much of the degradation that has occurred historically may be permanent, at least on a human time scale (Brown et al. 2005).

Enterprises that extract a good or service from rangelands can be degrading if they do not reduce pressure on the resource in periods of unusual climatic events. Managing rangelands in the face of global change requires a shift in focus toward the restoration and enhancement of ecosystem resilience. Management flexibility should be a goal at multiple spatial scales (Brown et al. 2005).

4.3.9.2 Summary of key conservation issues

Global climate change is anticipated to be potentially detrimental to arid rangelands over time. Current management actions should consider long-term impacts and

trends. The maintenance of resilient ecosystems is key to long-term maintenance. Changes in climate in the Intermountain area are expected to favor cool-season species of exotic invasives such as cheatgrass (Smith et al. 2006) and native trees such as juniper (USDA-Forest Service -PNW 2004). Restoration needs to consider these changes within the life-span of the restored vegetation, especially at the drier end of the vegetation continuum. New monitoring strategies will also be necessary. Key issues include:

- **Increase awareness of expected impacts of climate change:** Increased awareness of global climate change and the expected impacts of global climate change to sagebrush ecosystems are essential to effectively responding to these changes. Climate change is expected to be detrimental to arid rangelands including the sagebrush steppe, due to increases in cheatgrass and other weeds, juniper expansion, and increased wildfire risk. Ensuring that healthy sagebrush communities are maintained into the future will require adaptive management.

- **Maintain ecosystem resiliency:** Maintain maximum resiliency of ecosystems by maintaining and/or managing towards healthy, diverse, sustaining vegetation communities with high levels of vegetation vigor.

- **Control exotic invasive species:** Active management of exotic invasive species, such as cheatgrass, medusahead, and noxious weeds will be required to prevent continuing losses of native vegetation and the potential large-scale replacement of native plant communities with exotic communities. Detailed information on the spatial distribution of noxious weed species, such as spotted knapweed, leafy spurge, rush skeletonweed, and others is maintained by the Idaho Department of Agriculture through county-level Cooperative Weed Management Area programs and agency offices.

- **Restoration with suitable plant materials:** In restoration efforts in lower rainfall vegetation communities, include seed from warmer portions of a species range which will be better adapted to the predicted warmer conditions anticipated in the future. Factor climate change predictions into restoration efforts that are creating long-term vegetation communities.

- **Improved monitoring approaches:** Develop monitoring strategies to track subtle, long-term changes to the vegetative landscape.

4.3.9.3 Climate change conservation measures

Goal: Maintain resilience of sagebrush steppe vegetation communities as global climate changes increase the environmental stress on the community's ecological viability.

Issue Addressed	Rationale	Conservation Measure(s)
Increase awareness of expected impacts of climate change	Without awareness and understanding of the significance of climate change on the sagebrush ecosystem successful adaptive management is less likely to occur.	1. Support efforts by the Society for Range Management, and others to inform constituents of the seriousness of global climate change expectations. 2. Factor climate change needs and philosophy into current management of arid and semi-arid rangelands.
Maintenance of ecosystem resiliency	Conservative use and management will be necessary to allow plant communities to combat on-going environmental stress from climate change.	1. Avoid degradation of current vegetation communities. 2. Reduce pressure on the resource in periods of unusual climatic events such as drought. 3. Focus management of rangelands on restoration and resiliency of the vegetative resource.
Control exotic invasive species	Maintain viability of native plant communities by decreasing stress caused by undesirable invasive species.	1. Increase knowledge and awareness of invasive species problems on native ecosystems. 2. Reduce impacts of land uses that increase the rate of spread of invasive species. 3. Manage native plant communities to maintain biotic soil crusts (where appropriate), improve or maintain high vigor of native vegetation, and reduce use during periods when use favors invasive species ecologically. 4. Increase the pace of active control/elimination of invasive species in situations where other management is not capable of reducing the competition. Work closely with Cooperative Weed Management Areas/ programs to control noxious and invasive weeds.
Restoration with suitable plant materials	Restore plant communities that have the potential of	1. Include seed from the warmer part of a species' range in mixes that are used to restore degraded sites.

Issue Addressed	Rationale	Conservation Measure(s)
	surviving and adapting to climate change expectations.	2. Include Wyoming big sagebrush seed in mixes for drier/warmer areas that are on the lower transitional elevation fringes of mountain big sagebrush vegetative sites. Consider using alternative approaches to improve the likelihood of establishment, such as hand-planting seedlings, imprinters or other tools (See related discussion in Section 4.3.8.3). 3. Use local, native seed stock (where feasible and desirable) to reseed disturbed areas. 4. Anticipate impacts of climate change on biological control agents and potential for problems to native species.
Improved monitoring approaches	To manage the changes we must understand and anticipate the changes that are occurring.	As opportunities permit, cooperate with Universities and other partners to: 1. Define the capability of ecosystems and vegetation communities to withstand stress and/or disturbance and maintain capability of full recovery. 2. Develop high quality, consistent, and accessible soil and vegetation data and models that describe how changes occur in response to stress and disturbance. 3. Develop a system that identifies the effects of global change in the very early stages and identifies appropriate management responses. 4. Develop new concepts of landscape scale management of rangelands to provide for adaptive management in response to climate change. 5. Develop monitoring systems that track and predict how changes in land use and cover affect ecosystem function across spatial scales on rangelands. 6. Acquire quantitative knowledge of ecological thresholds, indicators of change, and key decision points in the framework of comprehensive monitoring systems. 7. Improve coordination and communication links between researchers and land managers.

Research, monitoring or evaluation needs: Define the capability of ecosystems and vegetation communities to withstand stress and/or disturbance and maintain capability of full recovery. Develop high quality, consistent, and accessible soil and vegetation data and models that describe how changes occur in response to stress and disturbance. Develop a system that identifies the effects of global change in the very early stages and identifies appropriate management responses. Develop new concepts of landscape scale management of rangelands to provide for adaptive management in response to climate change. Develop monitoring systems that track and predict how changes in land use and cover affect ecosystem function across spatial scales on rangelands. Acquire quantitative knowledge of ecological thresholds, indicators of change, and key decision points in the framework of comprehensive monitoring systems. Improve the commercial availability and supply of native grasses and forbs suitable for restoration in arid and semi-arid environments.

4.3.10 Conifer encroachment

4.3.10.1 Threat summary and background

The accelerated post-settlement expansion of conifer woodlands (mainly juniper species) occurred synchronously with the introduction of livestock, changes in mean fire-return intervals, and optimal climatic conditions (Tausch et al. 1981, Miller and Rose 1999, Miller and Tausch 2001). Juniper and pinyon woodlands have increased tenfold in extent since the late 1880s, and currently occupy 189,000 km^2 in the Intermountain region Miller and Tausch (2001). Connelly et al. (2004) estimated that 35% of sagebrush habitats in the Great Basin (Utah, Nevada) are at high risk of displacement by pinyon-juniper within the next 30 years, and summarizes the mechanisms by which encroachment occurs. Climate models suggest that expansion of juniper will continue throughout the 21st century (USFS-PNW 2004). Suring et al. (2005) estimated that over 4.2 million acres (1.7 million ha) of sagebrush cover types in the eastern Great Basin are at high risk of displacement by pinyon-juniper within the next 30 years. Miller et al. (2005) provide a detailed discussion on the biology, ecology and management of western juniper, and is recommended reading.

The projected encroachment of conifers into sagebrush communities and other important habitats constitutes a tangible, visible threat to sage-grouse in portions of several Idaho SGPAs, and is therefore of concern to several LWGs (Figure 4-15). Depending on the locality, conifer encroachment into breeding, late brood-rearing, fall, or winter habitat may be occurring, and should be addressed depending on local needs and priorities. Species such as western juniper (*Juniperus occidentalis*), Utah juniper (*Juniperus osteosperma*), and Douglas-fir (*Pseudotsuga menziesii*) are the species of primary interest depending on locality and elevation. To a lesser extent, encroachment by single-leaf pinyon pine (*Pinus monophylla*) and Rocky Mountain juniper (*Juniperus scopulorum*), or other species may also be of concern in certain situations.

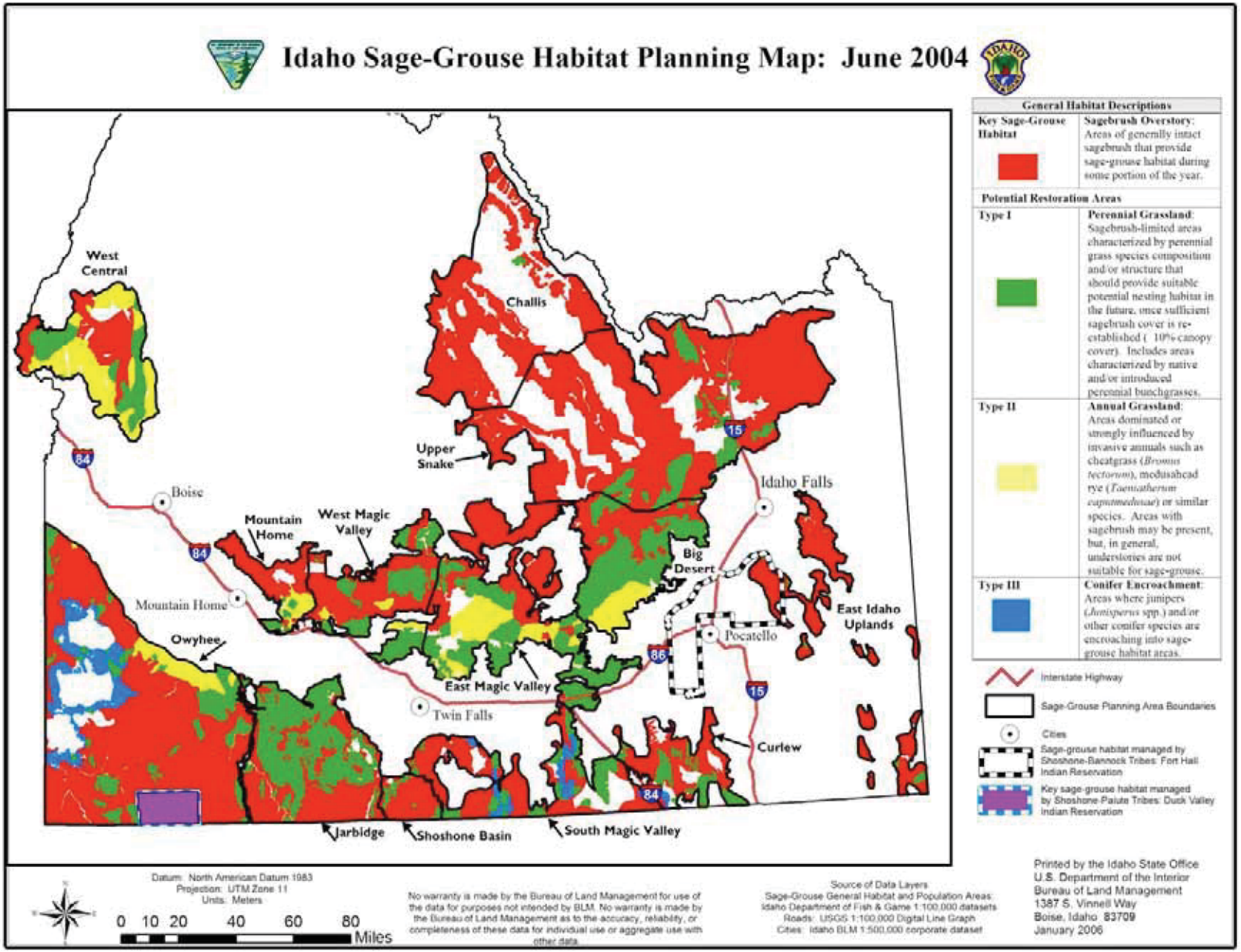


Figure 4-15 Idaho Sage-grouse Planning Areas and conifer encroachment. Blue areas indicate conifer encroachment.

4.3.10.2 Summary of key conservation issues

- **Spatial extent of conifer encroachment on the landscape:** Spatial analysis of the 2004 Idaho Sage-grouse Habitat Planning Map indicates approximately 355,004 acres of conifer encroachment in SGPAs (Table 4-12). BLM lands constitute 69% of the total, followed by private (22%), state (9%), and USFS (0.1%). Acres primarily reflect western juniper (Owyhee SGPA) or Utah juniper (Curlew, South Magic Valley SGPA) encroachment. Douglas-fir or other species may constitute an encroachment risk in portions of the Challis and Upper Snake SGPAs, or elsewhere, but encroachment zones have not been mapped or quantified to date. As mapping technologies and field inventory efforts improve, additional refinements will be incorporated. Again, while the extent of juniper encroachment on the southern Idaho landscape is relatively minor in comparison with seeded perennial grasslands or annual grasslands, its influence locally is of significant concern.

Table 4-12 Conifer encroachment acres by Idaho SGPA and land-ownership status (USDI-BLM 2004*a*).

	Acres[32]				
SGPA	**BLM**	**USFS**	**IDL**	**Private**	**Total**
Curlew	9,293	0	0	294	9,587
Owyhee	165,138	0	26,897	69,284	261,319
South Magic Valley	69,014	431	6,690	7,963	84,098
Total	**243,445**	**431**	**33,587**	**77,541**	**355,004**

- **Reduction of habitat quality:** Conifer encroachment typically occurs along or near the sagebrush-woodland interface due to the lack of wildfire or other disturbance. Over time, as juniper or other conifer cover increases, sagebrush cover and other understory species decline (Miller and Eddleman 2001, Miller et al. 2005). Consequently, over time, sage-grouse breeding, and brood and winter habitat declines both in quantity and quality. In some areas, particularly at higher elevations, the encroachment of conifers, including Douglas-fir, into wet meadows or riparian areas reduces brood habitat suitability. Pinyon pines, junipers or other trees or structures in the vicinity of leks provide potential perches for avian predators and appear to increase the risk of predation of males. Removal of trees within 100 m of leks doubled attendance by males two and three years post-treatment (Commons et al. 1998). It is assumed that removing

[32] BLM: Bureau of Land Management; USFS: U.S. Forest Service; IDL: Idaho Department of Lands. Acreages are approximate only and are reflective of the relatively broad nature of the 2004 Sage-Grouse Habitat Planning Map.

additional encroaching trees that occur beyond 100 m of leks is also beneficial, particularly if trees are relatively numerous or scattered, though the exact distance is unknown. Management of encroaching trees should be done carefully though, as other species of concern that utilize junipers, most notably the ferruginous hawk, may occupy the same habitats as sage-grouse.

4.3.10.3 Conifer encroachment conservation measures

Goal: To reduce the influence of conifer encroachment on sage-grouse and sage-grouse habitat.

Issue Addressed	Rationale	Conservation Measure(s)
All	Conifer encroachment into sagebrush communities reduces sage-grouse habitat quality and availability	1. LWGs, land management agencies, IDFG and other partners should work closely together to identify and prioritize conifer encroachment areas for further management action. Work cooperatively to identify options, schedules and funding opportunities for specific projects. For western juniper, Miller et al. (2005) provide *Guidelines for Selecting the Most Appropriate Management Actions*, on pages 54-57. 2. IDFG, land management agencies, LWGs and other partners should work closely together to identify leks where conifer encroachment may be affecting lek attendance or nearby habitat quality. 3. Remove Douglas-fir or other conifers where they are encroaching on wet meadows, riparian areas or sagebrush stands that provide potential sage-grouse habitat. 4. Remove juniper, Douglas-fir, pinyon pine, or other trees within at least 100 m (330 ft or 8-acre area) of occupied sage-grouse leks. The purpose of this procedure is to reduce perching opportunity for raptors or other avian predators within view of leks. Techniques could include chainsaw, chipper, or other suitable mechanical means. Ensure cutting and slash disposal is completed between approximately July 15 and January 30 to minimize disturbance to grouse that may be in the vicinity (e.g., males at leks, nesting females, young broods). This practice serves to reduce predation on sage-grouse by raptors by eliminating potential perches, thereby improving survival, recruitment, and productivity. It may be particularly valuable where avian predation may be of greater concern such as in areas with fragmented habitat, nearby infrastructure features, and/or in the

Issue Addressed	Rationale	Conservation Measure(s)
		case of small, isolated sage-grouse populations. 5. Where juniper or other conifer species have encroached upon sagebrush communities at larger scales, employ prescribed fire, chemical, mechanical (e.g., chaining, chipper, chainsaw, commercial sale) or other suitable methods to reduce or eliminate juniper. Priority should be given to areas where there is a strong likelihood for recovery of perennial herbaceous vegetation or where preparatory and follow-up actions (e.g., control of invasives, seeding) are likely to be successful. Whenever possible, but especially if sagebrush habitat is limited locally, use juniper control techniques that are least disruptive to the affected stand of sagebrush. For example, if junipers are only scattered, and the associated sagebrush community is otherwise relatively healthy, cutting junipers with chainsaws will remove the encroachment threat, while allowing for immediate use of the sagebrush by sage-grouse. In all cases, control efforts should be planned using interdisciplinary expertise. 6. On private lands, apply for OSC sage-grouse grant funds, or enroll in NRCS incentive programs related to sage-grouse/sagebrush habitats. Current NRCS programs that may provide some opportunities for economic offset of certain conservation measures include the CSP, WHIP, and EQIP programs. Landowners are encouraged to discuss the various opportunities available with their local NRCS district conservationist. Support for Idaho projects may also be available through the North American Grouse Partnership's (NAGP) Grouse Habitat Restoration Fund. Interested parties should contact Mr. Kent Christopher at (208) 356-0079 or grouse@fretel.com. 7. Where juniper control around leks is planned, monitor leks for at least 3 consecutive years post-treatment to document effects on lek attendance. Ideally, 2 to 3 years of pre-treatment monitoring is also recommended, but this may not always be feasible. 8. Plan wildfire suppression strategies to support this goal.

Research, monitoring or evaluation needs: Document and refine our understanding of how the reduction of conifer encroachment affects sage grouse populations or lek attendance.

4.3.11 Isolated populations

4.3.11.1 Threat summary and background

Most sage-grouse habitats and "populations" in Idaho are relatively contiguous and not isolated (2004 Idaho Sage-grouse Habitat Planning Map). However, of seven geographic areas in Idaho evaluated by the Panel, the West Central SGPA and southeastern Idaho area (East Idaho Uplands and Curlew SGPAs combined) were considered at greatest risk of sage-grouse extirpation. In particular, the West Central SGPA is separated from others by relatively large distances, and contains substantial annual grasslands and private lands. A portion of the South Magic Valley SGPA also includes what is assumed at this time to be a relatively isolated population inhabiting the Cotterel and Jim Sage Mountains. A small population existed historically in the Sawtooth Valley south of Stanley, but its current status is unknown.

4.3.11.2 Summary of key conservation issues

- **Need for better information related to population status and trends:** Little is known regarding population demographics of the isolated populations described above. Specifically, information on dispersal, genetic interchange, survival, and nest success is largely unknown. Monitoring underway in the West Central and Cotterel areas will help refine our understanding of these two areas.

- **Need for evaluation and monitoring of threats to isolated populations:** Isolated populations are of concern in that they are considerably more vulnerable to extirpation in the event of large wildfires, disease outbreaks (e.g., West Nile virus), predation influences, over-hunting, or other factors. Infrastructure features also may affect isolated populations to a greater extent, due to their small scale. Small, isolated habitats can also become occupied by invasive plant species in a short timeframe.

- **Need to improve or restore habitat associated with isolated populations:** The West Central SGPA and Cotterel/Jim Sage portion of the South Magic Valley SGPA include areas of annuals and/or conifer encroachment. In the latter area, cheatgrass control/restoration, burned area rehabilitation, and juniper management projects in the latter have been underway for several years.

4.3.11.3 Isolated populations conservation measures

Goal: To ensure that isolated sage-grouse populations remain viable.

Issue Addressed	Rationale	Conservation Measure(s)
Need for better information related to population status and trends	Status, survival and trend data relative to isolated populations is lacking	1. See Population Monitoring Section 5.2. 2. LWGs and agencies should coordinate in further refining and delineating sage-grouse populations, to the extent feasible.
Need for evaluation and monitoring of threats to isolated populations	The nature and extent of threats to isolated populations is unknown in some areas.	1. LWGs and agencies should work together to identify and quantify threats within isolated population areas.
Need to protect, improve or restore habitat associated with isolated populations	Some isolated population areas have substantial areas of habitat in need of restoration. See Idaho Sage-grouse Habitat Planning Map.	1. Ensure that vegetation prescriptions, hunting regulations, and permitted land-use activities are consistent with maintaining isolated populations and with maintaining or improving associated habitat. See conservation measures for specific threats.

Research, monitoring or evaluation needs: Better information on sage-grouse populations in priority areas is needed.

4.3.12 Predation

The majority of reported mortalities for grouse species, including sage-grouse, are due to predation (Bergerud 1988). However, predation plays a role in the ecology of every animal species, and is a natural process in all ecosystems. Prey species, including sage-grouse, play an important role in energy flow between trophic levels. In most prey species mortality is greatest during the early stages of development and decreases after young reach adult size, with relatively few of the young surviving to breed (Northeastern Nevada Stewardship Group 2004).

Sage-grouse are an important prey species commonly fed upon by a number of predators in Idaho. Coyotes, ravens and various raptors have also been noted to disturb or harass sage-grouse on leks (Bradbury et al. 1989). Sage-grouse appear especially wary of the presence of golden eagles (Hartzler 1974). While some level of predation should be expected in all sage-grouse populations, in certain situations predator/prey relationships may become disrupted, resulting in excessive predation. For example, the establishment of non-native predator species or an unusually high number of one or more predator species, may be cause for concern. Isolated or poor habitat conditions may also lead to increased predation. In general, predation has the potential to affect sage-grouse populations by reducing nest success, reducing the survival of juveniles, and/or reducing the survival of adult birds (Connelly et al. 2004). Some people assert that predation does not appear to be a widespread factor controlling sage-grouse populations (Connelly et al. 2004). However, others contend that predation may comprise a significant limiting factor to sage-grouse in some areas depending on localized variations in predator/prey relationships and local habitat conditions. Some Idaho LWG members believe predation is a serious limiting factor in their local SGPAs.

4.3.12.1 Threat summary and background

No predators are known to be dependent on sage-grouse as a primary food source (Connelly et al. 2004). Sage-grouse predators include the golden eagle (*Aquila chrysaetos*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*B. swainsoni*), common raven (*Corvus corax*), weasel (*Mustela* spp.), coyote (*Canis latrans*), and red fox *(Vulpes vulpes)* (Rasmussen and Griner 1938, Scott 1942, Patterson 1952, Dunkle 1977, Bunnell et al.1999. Predation of sage-grouse by ferruginous hawks (*Buteo regalis*) has been noted in southern Idaho (D. Gossett, personal communication 1/2006). Willis et al. (1993) suggested that year-to-year fluctuations of sage-grouse productivity in Oregon may be highly influenced by changes in the abundance of coyotes and ravens.

The relative abundance of coyotes in southern Idaho appears to have increased since the early 1950s, based on an index of aerial hunting effort (USDA-APHIS 2002). Other trend data are not available at this time. Fichter and Williams (1967) reported that red fox populations increased locally beginning in approximately 1960, and have been relatively abundant in southern Idaho for the past several decades (USDA-APHIS 2002). USFWS Breeding Bird Survey data suggest that raven populations have increased steadily since 1968 (USDA-APHIS 2002). New high-voltage power transmission lines resulted in an increased number of breeding raptors and ravens in southern Idaho and Oregon, on rangelands where natural nest substrates were previously lacking (Steenhof et al. 1993).

- **Predation of adults:** A number of predator species prey on both adult and juvenile sage-grouse including the coyote, badger (*Taxidea taxus*), bobcat (*Lynx rufus*), several species of raptors (Patterson 1952, Schroeder et al. 1999, Schroeder and Baydack 2001), and red fox (Bunnell et al. 1999).

  Some authors suggest that predation is an important influence on females during incubation and brood-rearing, and for males during the breeding season (Patterson 1952, Schroeder et al. 1999). In a Colorado study, Zablan (2003), reported annual survival rates of 59.2% for adult females, 77.7% for yearling females, 36.8% for adult males, and 64.5% for yearling males. Two studies in Idaho reported adult annual survival rates ranging from 42 to 75% (Connelly et al. 1994, Wik 2002). Annual survival of breeding-aged birds tends to be greater than 50% in most situations, and as high as 75% for breeding-aged females in Idaho. In general, survival rates for sage-grouse are higher than those of other gamebirds (Connelly et al. 1994)[33].

  Predation of nests: Nest predators noted in the literature include coyotes, badgers, ground squirrels (*Spermophilus* spp.), common raven, and magpies (*Pica pica*) (Patterson 1952, Schroeder et al. 1999, Schroeder and Baydack 2001). Corvids (ravens) have been reported by several authors to prey on sage-grouse nests, and/or chicks (Batterson and Morse 1948, Nelson 1955, Autenrieth 1981, Young 1994, Delong et al. 1995, Sveum 1995). In northern Nevada, videography has documented raven depredation of sage-grouse eggs (Pete Coates, personal communication, November 3, 2005).

  Patterson (1952) implicated Richardson's (*Spermophilus richardsonii*) and thirteen-lined ground squirrels (*S. tridecemlineatus*) in 42% of depredated sage-grouse nests across two study areas in Wyoming. However, Holloran (1999) documented visits to sage-grouse nests by Richardson's and thirteen-lined

[33] See Section 2.1 for more detailed discussion of sage-grouse ecology.

ground-squirrels with the aid of concealed motion-sensitive cameras, but concluded these species were not responsible for predation. While neither Richardson's nor thirteen-lined ground squirrels occur in Idaho, several species of ground squirrel are present (Yensen and Sherman 2003). Thus, the risk and magnitude of nest predation or egg disturbance by ground squirrels in Idaho remains uncertain.

Overall, the literature suggests that sage-grouse nest success varies between 14.5% and 86.1% (Connelly et al. 2004). Bergerud (1988) considered sage-grouse nest success as generally low, averaging 35%, across 12 studies (n=699 nests). Nest success across 16 radio-telemetry studies across 7 states and provinces (n=1,225 nests) averaged 47.7% (Connelly et al. 2004). Nest success for sage-grouse in Idaho, across three radio telemetry studies averaged over 49% (Connelly et al. 2004).

Habitat loss or reduction may concentrate nesting female sage-grouse, reducing the size of area predators need to search (Bergerud 1988). Man-made features, such as those that provide avian perch sites, travel lanes or dens, may also lead to nest predation, by facilitating predator access to nesting habitats (Bergerud 1988). In general, the canopy cover of tall grasses and medium height sagebrush is inversely related to the probability of nest predation (Connelly et al. 1991, DeLong et al. 1995, Sveum et al. 1998 cited in Crawford et al. 2004).

Connelly et al. (2004) cite several more recent studies that documented sage-grouse survival and nest success (Gregg 1991, Robertson 1991, Connelly et al. 1993, Gregg et al. 1994, Holloran 1999, Lyon 2000, Wik 2002). Among these seven studies, only Gregg (1991) and Gregg et al. (1994) reported that predation was limiting sage-grouse populations by limiting nest success; and in these cases the relationship was linked to poor nesting habitat. Connelly et al. (2004) suggest that since most studies report nest success rates exceeding 40%, nest predation is not a widespread problem. Little information is available regarding the impacts of predator control on nest success. In Wyoming coyote control actions failed to produce an effect on nesting success (Slater 2003).

- **Predation of juveniles:** Young birds may be killed by the common raven, northern harrier (*Circus cyaneus*), and weasel (Schroeder et al. 1999). Red-tailed hawks and ferruginous hawks (*Buteo regalis*) have also been noted to prey upon juvenile sage-grouse (Patterson 1952 cited in Autenrieth 1981). Carhart (1942) cited in Autenrieth (1981) reported juvenile sage-grouse remains in 55% of Swainson's hawk nests visited. Available information suggests that juvenile survival is low, but this factor has been difficult to document in the field (Crawford et al. 2004). Predation of juveniles may be particularly important during the first few weeks after hatch (Connelly et al. 2004). In Montana,

survival of sage-grouse chicks during the first three weeks after hatching was 37% (Wallestad 1975 cited in Schroeder and Baydack 2001). From 1999-2002, research was conducted on chick survival in the Upper Snake SGPA (N. Burkpile, University of Idaho, in progress). Information forthcoming in the near future from this study should contribute useful new information regarding juvenile survival.

4.3.12.2 Summary of key conservation issues

An array of predator species may potentially influence sage-grouse populations. Predator control, as a practice, is controversial from ethical, economic, and effectiveness perspectives. Some people believe that predators are a major factor limiting sage-grouse, and feel that more effort should be expended on predator control activities. Others contend that since predation is a natural process, predators should not be controlled at all. Still others believe that predator control may be appropriate in certain situations, or only as a last-resort. Schroeder and Baydack (2001) suggested that as populations of prairie grouse become smaller and more threatened, direct control of predators may need to be considered more carefully. Predator-related issues that may require specific conservation responses are grouped under the single conservation issue that follows.

- **Excessive levels of predation can be detrimental to sage-grouse populations:** While some level of predation is always to be expected, the question of how much predation is acceptable before control actions are initiated is difficult to assess. Related to this question is the difficulty of understanding the complex interactions of multiple threats and landscape conditions, and how these factors collectively influence predation.

  There is no universally accepted definition of excessive predation. Indicators of excessive predation may include on a three year running average: nest success rates below 25%, production rates below 2.25 juveniles per adult hen, adult female annual survival rates below 45%, in combination with declining population indices and assuming habitat and weather conditions are normal. Site-specific conditions influence what constitutes excessive predation. Moreover, isolated and at risk populations may not fit within these criteria.

  Factors such as poor habitat quality, habitat fragmentation, and isolation of populations, may result in excessive predation on one or more sage-grouse sex or age-classes (e.g., egg, juvenile, adult female/male). The nature and degree of infrastructure development in some areas may also exacerbate predation risk, by concentrating certain predators. Very small or isolated populations have the

potential to disappear in short timeframes due to the generally low reproductive rates of sage-grouse, and because grouse utilizing small areas of habitat are more vulnerable to predators.

Man-made structures can facilitate avian predation of sage-grouse. While we have a generally good understanding of lek locations and man-made structures in many areas, typically we do not know which structures may be posing a problem.

More information is also needed to determine the presence and possible effects of non-indigenous predators or abnormally high levels of predators on sage-grouse populations, regardless of habitat quality.

Because of the many variables and uncertainties associated with excessive predation, there is a clear need for a systematic approach that LWGs can use to assess sage-grouse population status, habitat conditions and threats at the local level so that appropriate actions can be identified and pursued. LWGs should utilize the approach outlined below, though LWGs may consider additional criteria, depending on local issues and conditions.

4.3.12.2.1 Considerations for addressing sage-grouse predation issues in Idaho

Site-specific conditions, such as habitat quality or isolation, or weather events (e.g., extended drought) may influence predation at any given location. Due to cost, logistical, ecological and societal concerns related to predator control, it is essential to first adequately describe the context within which predation is operating, and to determine if predator control is indeed warranted. It is also essential that all interested parties, including APHIS-Wildlife Services be involved at the outset.

Local Working Groups should consider the following questions when determining the nature and extent of potential predator problems in a specific geographic area. The process outlined below will also be helpful in identifying other threats. Suggested threshold population indices or "triggers" are provided where appropriate. It is important that LWG members discuss these questions and document conditions prior to proposing predator control actions. Such a systematic approach will help guide their local planning efforts and will help to ensure that excessive predation and other threats are dealt with appropriately.

1. **What is the status of the sage-grouse "population" in question (on a three-year running average)?**
    - Is the population considered isolated or is it a stronghold? Refer to the latest version of the Idaho Sage-grouse Habitat Planning Map.

- Is the population migratory or non-migratory?
- Is the status of each lek known? Are lek counts conducted annually? Is production assessed annually?
- Are population trend indices (e.g., lek counts) declining, stable, or increasing?
- If population trend is down, what are the reasons? Has there been a recent drought or large wildfire or other factor influencing trend?
- Is annual productivity, as determined by the fall ratio of juveniles/ hen below 2.25? (Note: 2.25 juveniles/hen is the suggested indicator for stable or increasing populations, Connelly and Braun 1997 and Edelmann et al. 1998).
- Is nest success (proportion of nests that hatch at least one egg per season) less than 25%? Connelly et al. (2004) reported a range of 14.5% to 86.1%.
- Is average adult female survival rate less than approximately 45%? Connelly et al. (2004) report a range of 48-75%.
- Is annual hunter harvest within recommended WAFWA Guidelines? See Sport Hunting section for additional details.

2. **What is the status of sage-grouse habitat in the area?**
   - Are the important seasonal habitats known (breeding, late brood, winter)?
   - Are seasonal habitats generally contiguous or fragmented?
   - Do the respective seasonal habitats generally meet WAFWA Guidelines, or is there a considerable departure from the Guidelines for one or more of them?
   - If there is a departure from Guidelines, what can or should be done to restore desired habitat conditions (long-term habitat restoration combined with short-term predator control)?
   - What is the land status? Predominantly private, public, mixed?

3. **What is the nature and extent of other threats in the area?**
   - Is infrastructure (e.g., power pole cross-arms, or other man-made structures) providing opportunities for ravens or raptors to perch or nest in proximity to important habitats?
   - Is conifer encroachment inhibiting lek quality or activity?
   - Is human disturbance of leks or breeding habitat a significant factor?

4. **What is the status of predation and predators in the area?**
   - What potential predator species are present?
   - Do the predator species of concern have legal protection through state or federal law (e.g., game or protected non-game, Endangered Species Act, Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, etc.) Who has management authority for the predator species?

- Is the suite of predators or population levels present inconsistent with what is expected in healthy sagebrush steppe habitats? Are there non-indigenous predators present?
- Has excessive predation of nests, juveniles or adults been documented?
- What is the predicted population response of other predator species to removal of the target species?

5. **If predator control is recommended:**
    - Is a viable control method and adequate funding available?
    - Have humane predator control techniques been considered as a first option wherever possible?
    - Have clear objectives been defined that describe when successful control has been achieved?
    - Can the predator species of concern be identified and effectively targeted?
    - If so, is lethal take recommended or are there non-lethal or passive control alternatives?
    - Are surrounding landowners supportive?
    - Has the appropriate environmental analysis been completed?
    - Has the proposed action been adequately designed with suitable control and treatment areas, so effects can be assessed and documented?
    - Have pre-treatment and post-treatment monitoring protocols been established?

4.3.12.3 Predation conservation measures

Goal: Manage excessive predation to enhance sage-grouse survival and production as appropriate to local conditions.

Issue Addressed	Rationale	Conservation Measure(s)
Excessive levels of predation can be detrimental to sage-grouse populations	The scale, quality or configuration of habitat; infrastructure; non-indigenous predator species or artificially high predator populations may contribute to excessive predation.	1. Evaluate local conditions using the systematic approach presented above in Section 4.3.12.2.1. Depending on the outcome of the local evaluation consider implementing one, or a combination, of the conservation measures identified below: A. If excessive predation is the result of poor habitat conditions: ▪ Take actions to correct the habitat deficiencies for the long-term. ▪ Consider predator control for at risk or isolated populations as a short-term measure.

Issue Addressed	Rationale	Conservation Measure(s)
		B. If excessive predation is the result of artificial structures or developments (e.g., fences, roads, power lines, landfills, etc.) or if the presence of such structures in proximity to important habitats is suspected to be a problem: ▪ LWGs and agency personnel should work closely with utilities, agencies, landowners, and others to document problem areas and develop suitable solutions on a case-by-case basis. ▪ New man-made structures or developments should be designed and sited to minimize effects on sage-grouse populations. ▪ Consider predator control for at risk or isolated populations as a short-term measure. C. If excessive predation is the result of non-indigenous predator species or artificially high predator populations: ▪ Where possible, eliminate factors contributing to artificially high predator populations (e.g., unnatural food sources including landfills, dead animal pits, artificial nest substrates, etc.) ▪ Cooperate with Wildlife Services and IDFG in designing and implementing appropriate control measures. Ideally, such efforts should include monitoring that provides comparisons of habitat conditions and predator-species compositions between treatment and control (non-treatment) area(s).

Research, monitoring or evaluation needs: There is a need for additional research, as well as monitoring and evaluation activities to investigate: the behavior of predator species, the intra- and inter-specific relationships of predator populations, the impact of predators and other mortality factors on specific sage-grouse populations of concern, and on sex/age classes. Need to develop better methodologies to assist in identification of predator species linked to sage-grouse predation. Research is needed to determine the factors that affect habitat quality as it relates to the level of predation. Research is needed to determine the effect of habitat fragmentation as it relates to the level of predation. Finally, there is a need to experimentally implement and evaluate predator control measures in areas where predation is suspected to be limiting sage-grouse, to gain a greater understanding of the effects of this management approach on sage-grouse, specific predators, and the relationship between predator species.

4.3.13 Urban/exurban development

4.3.13.1 Threat summary and background

Risk to ecological integrity is generally higher in proximity to areas with dense human population. Higher population densities in proximity to forest and rangeland vegetation types are rated as having higher risk than low population density areas. In contrast, well-managed, viable ranches and livestock grazing allotments can provide habitat and open space needed by sage-grouse and some other wildlife. Road building, camping, hiking, off-road vehicle use, development of recreation sites, and human-caused wildfire are all examples of activities and impacts that tend to increase in wildland areas in close proximity to population centers, with larger population centers having higher activity levels. Ada and Canyon counties meet these criteria as densely populated areas in Idaho. In the Columbia River Basin, 58% of the area is classed as low urban/rural area with approximately 23% as high or very high. Twenty-one percent has high or very high risk of ecological impacts (see Quigley et al. 1996).

Urban areas themselves remove habitat and present inhospitable environments for sage-grouse. However, the connecting roads, power lines and communication corridors, and use of surrounding regions for recreation exert a greater influence on sagebrush habitats (Connelly et al. 2004). In general, urban sprawl impacts sage-grouse to the extent that it infringes on sagebrush communities.

Increased affluence has also resulted in additional uses of lands surrounding cities for development of homes on larger acreages (e.g., ranchettes) (Connelly et al. 2004). Also, within the geographic distribution of sage-grouse, human populations have grown and expanded over the past century, primarily in the western portion of the sagebrush biome (Connelly et al. 2004). In Idaho, the resident population has more than doubled during the past fifty years, increasing from 588,637 to 1,293,594 in 2000 (U.S. Census Bureau statistics).[34] Areas surrounding Idaho Falls, Pocatello, and the lower Big Wood River Valley have development expanding into sagebrush habitat. While much of the actual footprint of recent urban/exurban expansion in Idaho is probably occurring outside of SGPA boundaries, in association with communities along I-84/I-15 corridors, for example, the potential for increasing movement into more intact sagebrush communities is very real. Urban/exurban expansion and population growth are closely related to other threats such as infrastructure development, human-caused wildfires, human disturbance, and climate

[34] http://www.census.gov/dmd/www/resapport/states/idaho.pdf

change, thus the direct and indirect influences of urban/exurban expansion are quite complex and far-reaching.

4.3.13.2 Summary of key conservation issues

Non-urban areas have been developed throughout the sagebrush region because of economic factors combined with opportunities for recreation and other natural amenities (Riebsame et al. 1996, cited in Connelly et al. 2004**).** In addition, many "exurbanites" have migrated from cities into "ranchettes" created by subdividing larger ranches. While ranchettes may provide some sagebrush habitat as opposed to complete urbanization, such areas are probably rendered unsuitable for sage-grouse due to fragmentation and disturbances associated with new roads, dwellings, and human disturbance (Connelly et al. 2004).

- **Loss of habitat:** Loss of sage-grouse habitat is the primary conservation issue associated with urban/exurban development and can be subdivided into three major categories (1) direct loss of sage-grouse habitat through development of previously occupied habitat for home sites and ranchettes, (2) direct loss of habitat through development of infrastructure to support the above home site developments, and (3) loss of habitat through physical degradation and human activities radiating out from the above developments.

4.3.13.3 Urban/exurban conservation measures

Goal: Protect sagebrush/sage-grouse habitats from losses caused by urban expansion and related human caused impacts.

Issue Addressed	Rationale	Conservation Measure(s)
Direct loss of sagebrush habitat to development of homes and ranchettes	Maintain habitat in what is often critical seasonal habitat areas.	1. Work with county and city zoning and planners to avoid developing important sagebrush habitat. 2. Educate landowners and developers to values of sagebrush habitat. 3. Acquire easements when owners are willing to negotiate conservation agreements. 4. Acquire habitat where there are willing sellers and when it provides the best option to protect and/or restore important habitats: A. Identify important parcels of habitat;

Issue Addressed	Rationale	Conservation Measure(s)
		B. Work with landowners to identify willing sellers; C. Use existing funding sources for acquisition. 5. Protect wildland areas from wildfire originating on private lands, infrastructure corridors and recreation areas. 6. Off-site mitigation should be employed to offset unavoidable alteration and losses of sage-grouse habitat. Off-site mitigation should focus on acquiring, restoring, or improving habitat within or adjacent to occupied habitats and ideally should be designed to complement local sage-grouse conservation priorities.
Direct loss of habitat through development of infrastructure to support site development	Maintain maximum amount of suitable habitat in conditions acceptable to sage-grouse and other sagebrush dependent species.	1. Work with county and city zoning and planners to avoid developing important sagebrush habitat. 2. Educate landowners and developers to values of sagebrush habitat. 3. Acquire easements when owners are willing to negotiate conservation agreements. 4. Off-site mitigation should be employed to offset unavoidable alteration and losses of sage-grouse habitat. Off-site mitigation should focus on acquiring, restoring, or improving habitat within or adjacent to occupied habitats and ideally should be designed to complement local sage-grouse conservation priorities.
Loss of habitat through physical degradation and human activities radiating out from the above developments	Maintain maximum amount of suitable habitat in conditions acceptable to sage-grouse and other sagebrush dependent species.	1. Work with county and city zoning and planners to avoid developing important sagebrush habitat. 2. Educate landowners and developers to values of sagebrush habitat. 3. Acquire easements when owners are willing to negotiate conservation agreements.

Research, monitoring or evaluation needs: Parcels of private land suitable as sage-grouse habitat or related habitat values (e.g., potential for restoration) that are susceptible to loss to development or to uses related to new developments need to be identified for potential land exchange, conservation easements or related actions. Identify potential impacts to public lands from human occupancy and related factors (e.g., infrastructure) on adjacent private lands.

4.3.14 Sagebrush control

Due to similarities in management objectives the discussion of sagebrush control was combined with the discussion of prescribed fire presented in Section 4.3.7. This combination is not intended to elevate the threat of sagebrush control to that of prescribed fire, but to clarify the inter-relationships of the techniques to manage sagebrush habitat. Section 4.3.7 contains the presentation of threat summary and background, summary of key conservation issues, and conservation measures, associated with both prescribed fire and other methods of sagebrush control.

4.3.15 Insecticides

4.3.15.1 Threat summary and background

Sage-grouse using agricultural areas for brood-rearing can be exposed to pesticides (Connelly et al. 2000*b*). Organophosphate insecticides, such as dimethoate and methamidophos applied to crops can adversely affect sage-grouse (Blus et al. 1989). In Idaho, 63 out of 200 sage-grouse foraging in alfalfa and potato fields died after exposure to organophosphate insecticides in those fields (Blus et al.1989). Since sage-grouse often move long distances between seasonal habitats, the total sage-grouse use area influenced by chemicals may be quite large (Connelly et al. 2004). Ingestion of sub-lethal levels of pesticides by birds can result in abnormal or lethargic behavior, increasing risk of predation (see Insecticides, USDI –FWS 2005).

Mormon crickets and native rangeland grasshopper species are a normal component of the biota, and feed on grasses, forbs, and shrubs (USDA APHIS-PPQ 2004*a,b*). Since young sage-grouse hatch in the spring approximately the same time as Mormon cricket and grasshopper populations begin to mature (USDA-APHIS-PPQ 2004*a*,*b*), and since insects provide a critical source of protein for young grouse, grasshopper and Mormon cricket control efforts have the potential in some cases to impact food availability. Conversely, Mormon cricket and grasshopper infestations may impact herbaceous cover but the impact on sage-grouse has not been quantified. For example, Mormon crickets at a density of 10 per square yard can consume 375 lbs. of dry matter per acre over the course of a four-month lifespan (Cowan 1990 cited in USDA APHIS-PPQ 2004*a*).

Rangeland grasshopper and Mormon cricket control efforts employing malathion, diflubenzuron and/or carbaryl bait reduce grasshopper or Mormon cricket densities in target areas. However, Norelius and Lockwood (1999 cited in USDA-APHIS 2002), suggest that while grasshopper densities can approach 60/m^2 during outbreaks, treatments that have a 90-95% mortality rate (of grasshoppers) still leave a density of grasshoppers (3-6/m^2) that is greater than an average density found on rangelands, such as Wyoming, in a normal year (Schell and Lockwood 1997 cited in USDA-APHIS 2002).

Up to five million acres of federal rangeland in Idaho were anticipated to be infested by Mormon crickets and grasshoppers in 2005 (USDA APHIS-PPQ 2005). The chemical control of grasshoppers or Mormon crickets on Idaho rangelands has the potential to reduce the abundance and/or diversity of non-target insect species utilized by sage-grouse broods in certain areas. However, in sagebrush steppe situations, no more than 50% of treatment blocks receive direct application (USDA APHIS-PPQ

2005). Also, treatment acreages on federal lands have been comparatively low (Table 4-13) (USDA APHIS-PPQ 2005; R. McChesney, USDA APHIS-PPQ personal communication 1/2006). Specific treatment acreage figures for state and private lands are not readily available. However it is likely that, including state, private, and federal lands, less than 2.5% of the area inhabited by crickets and grasshoppers would be treated in a given year, even during outbreaks (R. McChesney USDA APHIS-PPQ personal communication 1/2006).

Table 4-13 Acres of federal Idaho rangelands treated for Mormon crickets and grasshoppers.

	Federal Acres Treated in Idaho	
Year	**Mormon Crickets**	**Grasshoppers**
2005	68,520	2,394
2004	18,945	2,520
2003	13,585	11,705
2002	340	250
2001	--	420
2000	--	1100

4.3.15.2 Summary of key conservation issues

- **Impacts of agricultural pesticides on sage-grouse:** Sage-grouse adults and broods have been noted to forage in irrigated farm fields. The use of certain insecticides, such as organophosphates, on agricultural crops while sage-grouse were present has resulted in mortality of birds in some cases. Other effects of organophosphates on birds, such as reduced alertness, can increase vulnerability to predation.

- **Impacts of Mormon cricket and rangeland grasshopper control on sage-grouse:** Mormon cricket and grasshopper control has the potential to adversely affect food availability for sage-grouse in certain areas.

4.3.15.3 Insecticide conservation measures

Goal: Reduce the direct and indirect mortality of insecticides on sage-grouse while still providing for adequate control of insects.

Issue Addressed	Rationale	Conservation Measure(s)
Impacts of agricultural pesticides on sage-grouse	Some agricultural chemicals can cause direct or indirect mortality	1. Avoid the use of organophosphates on fields utilized by sage-grouse, or allow for suitable treatment buffers around field edges. Incentive or enhancement payments to offset economic impacts

Issue Addressed	Rationale	Conservation Measure(s)
	of sage-grouse foraging in farm fields.	to farmers may be available through NRCS CSP or other programs. Farmers/landowners are encouraged to discuss options with their local NRCS District Conservationist. 2. Work with plant and insect specialists to develop strategies that could be used to protect crops near sage-grouse habitat from insects, thus minimizing the use of insecticides. Planting the outside field borders with certain plants that attract, repel or control insects may be feasible. 3. As alternative brood habitat, manage nearby native habitats, especially moist meadows and riparian areas to be more attractive (e.g. cover, forb availability and diversity) to sage-grouse and broods. 4. LWGs, Cooperative Extension agents, NRCS, IDFG, NAGP and other partners should collaborate to inform farmers of concerns with insecticide use and to develop collaborative solutions to reduce adverse impacts to sage-grouse.
Impacts of Mormon cricket and rangeland grasshopper control on sage-grouse	Mormon cricket and rangeland grasshopper control may reduce food availability for sage-grouse in certain areas.	1. LWGs, land management agencies, landowners, IDFG, IDA, and APHIS-PPQ should continue to collaborate closely to ensure annual control efforts focus on key problem areas, better delineate treatment avoidance areas, determine the treatment of least risk to sage-grouse, and monitor results.

Research, monitoring or evaluation needs: Document mortalities of sage-grouse resulting from pesticide-use to improve our understanding of the extent of this threat. Monitor the impacts of Mormon cricket and rangeland grasshopper control efforts on sage-grouse food (insect) availability in control versus treatment areas. Monitor the effects of Mormon cricket and rangeland grasshopper control with respect to herbaceous and shrub cover in treated and untreated areas.

4.3.16 Agricultural expansion

4.3.16.1 Threat summary and background

Large-scale losses of big sagebrush in Idaho since historical times were largely attributed to increases of agricultural lands, as well as conversion of shrub-steppe vegetation to exotic forbs and annual grass (Wisdom et al. 2000). Prime areas for growing crops (e.g. areas with deeper, fertile soils) were claimed first during settlement (Connelly et al. 2004).

4.3.16.2 Summary of key conservation issues

- **Habitat loss and fragmentation:** Hironaka et al. (1983) estimated that 99% of the basin big sagebrush type (which grow on deeper soils) in the Snake River Plain has been converted to cropland. Nearly one-third of lands in the Upper Snake Ecosystem Reporting Unit (which includes portions of several SGPAs) are described as currently agricultural (Wisdom et al. 2000). Technological improvements in irrigation methods now permit agriculture development on steeper terrain (Connelly et al. 2004).

- **Insecticides:** Chemicals applied to crops can also directly or indirectly affect sage-grouse foraging in farm fields. (See discussion in Insecticides Section 4.3.15.)

- **Predation:** Agricultural development, in addition to direct sage-grouse habitat loss or fragmentation, also influences adjoining sagebrush habitats due to increases in certain predators, such as red fox, ravens, and domestic cats (Vander Haegen and Walker 1999 and Vander Haegen et al. 2002 cited in Connelly et al. 2004). (See discussion in Predation Section 4.3.12.)

4.3.16.3 Agricultural expansion conservation measures

Goal: Manage existing and future agricultural lands in a manner that minimizes or reduces direct and indirect impacts to sage-grouse.

Issue Addressed	Rationale	Conservation Measure(s)
Habitat loss and fragmentation	Conversion of additional sagebrush lands to agriculture	1. Utilize the Conservation Reserve Program, Wetland Reserve Program, Grasslands Reserve Program, Farmland Protection Program or similar

	may adversely affect sage-grouse.	USDA incentives programs to recover habitat for sage-grouse where feasible. 2. Where possible, avoid additional agricultural expansion into key habitat or potential restoration areas. 3. Where there are willing landowners, identify and prioritize parcels available for purchase or exchange that could be restored to perennial grasses, forbs and shrubs. 4. Within LWGs, and with willing landowners, identify options for lands on the Snake River Plain recently withdrawn from irrigation. Options may exist for collaboratively funded restoration projects or development of forage reserves. 5. Where opportunities allow (incentives, partnerships, willing landowner, etc.), off-site mitigation should be employed to offset unavoidable alteration and losses of sage-grouse habitat. Off-site mitigation should focus on acquiring, restoring, or improving habitat within or adjacent to occupied habitats and ideally should be designed to complement local sage-grouse conservation priorities.
Insecticides	Certain insecticides can cause direct or indirect impacts to sage-grouse	See Insecticides Section 4.3.15.
Predation	Agricultural expansion can increase certain types of predation	See Predation Section 4.3.12.

Research monitoring or evaluation needs: Identify sagebrush communities and potential restoration areas that are susceptible to agricultural development for targeted acquisition, conservation easements or related actions. Document and report sagebrush acreage converted to agriculture at periodic intervals (to be determined) by county.

4.3.17 Sport hunting

4.3.17.1 Threat summary and background

Controversy over the impacts of sage-grouse hunting dates to the early part of the 20th century (Hornaday 1916). Sage-grouse hunting has been a tradition in Idaho for many generations and many families spent opening weekend camped in sage-grouse country. During the early 1980s over 30,000 hunters pursued sage-grouse every year. Early research suggested that hunting had little impact on sage-grouse populations (June 1963, Crawford 1982, Braun and Beck 1985). Wallestad (1975) reported that despite fluctuating population trends, Montana maintained liberal sage-grouse seasons because of high annual turnover, "law of diminishing returns," and "opening day phenomena." Harvest was generally thought to be a compensatory form of mortality (the proportion of the population that was harvested would die from some other factor if hunting did not occur). However, recent research has suggested that sage-grouse may be more susceptible to over-harvest than other upland game bird species because they have population characteristics that include relatively low reproductive rates, long lives, low annual turn-over, and high over-winter survival (Schroeder et al. 1999).

Autenrieth (1981) and Crawford and Lutz (1985) suggested that hunting may have negative effects on sage-grouse populations. Johnson and Braun (1999) concluded that up to some threshold level, hunting mortality was compensatory, but at or beyond that level, exploitation of sage-grouse may be additive (the number shot adds to those that die from other causes). Recent research in California, Nevada, and Wyoming also provided evidence indicating that hunting at some level may impact subsequent breeding populations (Connelly et al. 2004). Connelly et al. (2000*a*, 2003*a*) concluded that hunting can slow the rate of increase for sage-grouse populations and that harvest losses are likely additive to winter mortality and may result in lower breeding populations. However, a reported direct recovery rate of 7-10% of banded birds in North Park, Colorado, occurred from 1973 to 1990, a period when the number of displaying males counted increased from about 580 to over 1,500 (Zablan et al. 2003).

A more complete review of the impacts of hunting on sage-grouse is provided in Connelly et al. (2004). See also Connelly et al. (2005) for a comprehensive overview of historical and current thinking with respect to harvest management.

In 1953 when the first sage-grouse harvest estimates were developed for Idaho, season regulations were very conservative, as they were for most upland game species in Idaho. This approach reflected uncertainty over the impacts of bag limits

and season lengths on hunter harvest and participation. From 1953 through 1989, seasons varied from 1-14 days, and the estimated annual statewide harvest averaged 40,000 to 50,000 sage-grouse. From 1990 to 1995, the season was 30 days long statewide with an estimated annual harvest of about 25,000 sage-grouse. From 1996 to 2001, season frameworks varied across the state and estimated annual harvest declined to under 10,000 birds. From 2002-2004, seasons remained conservative relative to historic levels and estimated annual harvest averaged about 7,800 birds.

Methods used to estimate harvest varied from 1953 to 1999, and included a voluntary mail survey until 1983, and a telephone survey from 1983 to 1999. The sample size of hunters surveyed and accuracy of these two methods varied as survey budgets expanded and contracted. Since 2000, a special permit has been required to hunt sage-grouse and sharp-tailed grouse. This permit system has allowed for more efficient identification and sampling of Idaho sage-grouse hunters and provides more precise harvest estimates. The Department now interviews about 30% of the total number of permit-holders annually to develop harvest estimates. For example, IDFG interviewed 2,010 (27%) of the estimated 7,382 sage-grouse hunters in 2004.

Based on the annual permit-holder survey, since 2000 the estimated annual harvest of sage-grouse has averaged about 7,800 birds taken by about 6,000 hunters. This is less than 25% of the hunter and harvest estimates made before 1996. The apparent decline in hunter participation probably reflects more restrictive seasons and perceptions of lower sage-grouse populations. These two factors may have reduced interest in sage-grouse hunting although sage-grouse numbers have generally increased in Idaho since 1996. The opportunity to hunt sage-grouse provides population and distribution data (e.g., wing barrels and hunter interviews). In addition, interest in hunting contributes to support for sage-grouse conservation and maintains an Idaho tradition.

In 2004, sage-grouse hunter check stations were conducted on opening weekend at 16 locations throughout southern Idaho (Figure 4-16). Wings collected at check stations and wing barrels placed at 27 sites across the state provide information on the age and sex composition of harvested birds. Using these methods, over 3,000 hunters were interviewed at check stations in 2004 to document hunter activities and about 2,000 wings were collected and aged to document production.

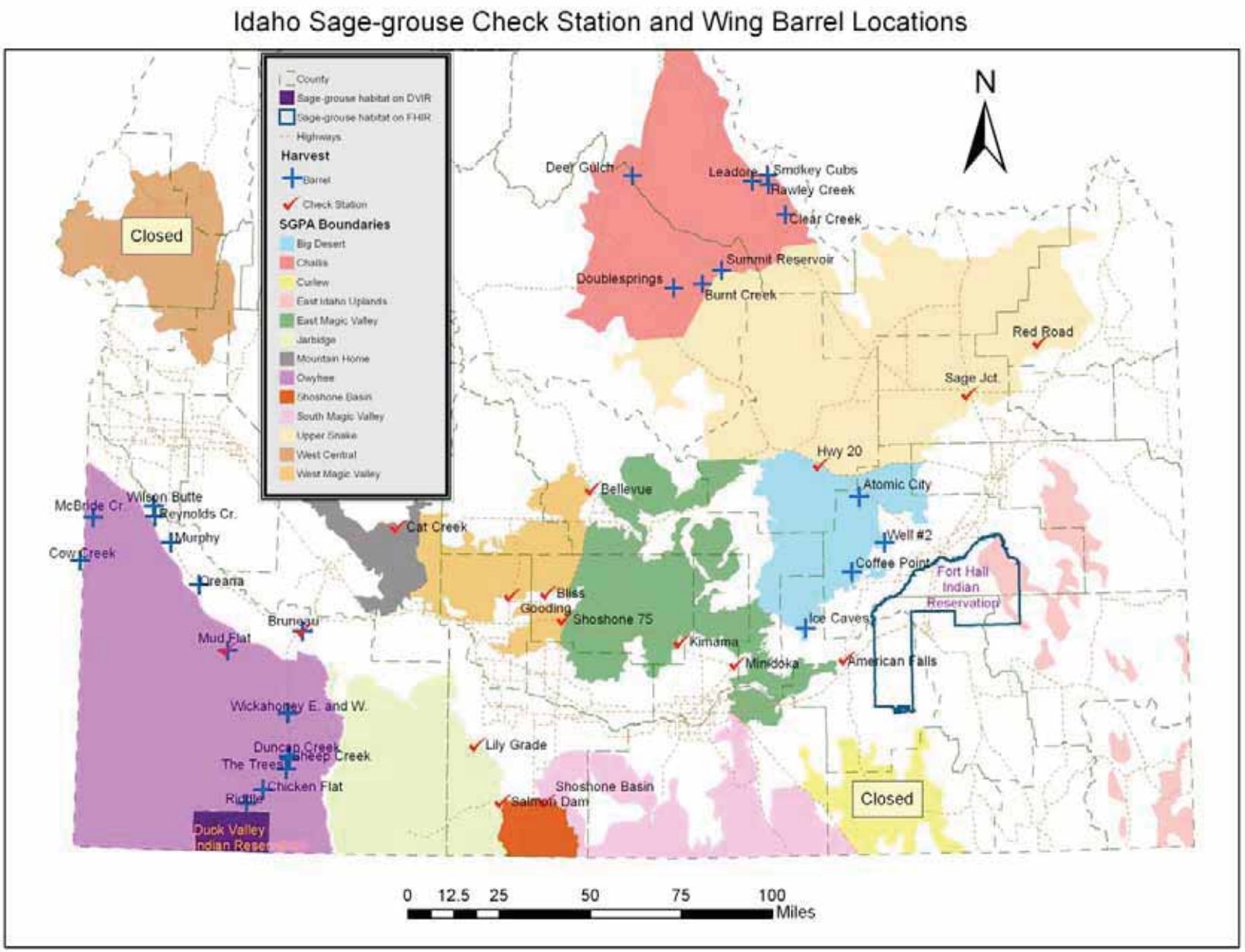


Figure 4-16 Sage-grouse wing barrel and check station locations

Data from wing barrels in the Southwest Region indicate that in an area with a 23-day season, 55% of the total wings (n=665) are collected during opening weekend, 24% the second weekend, 17% the third weekend, and 4% the fourth weekend (2004 data).

Because of concerns over the effect of harvest on sage-grouse, IDFG biologists are actively evaluating the effects of hunting on Idaho sage-grouse. Existing data support the conclusion that the current Idaho sage-grouse season structure is well within suggested hunting guidelines (Connelly et al. 2000*b*, Wambolt et al. 2002).

4.3.17.1.1 Falconry

For the purposes of this Plan the discussion of falconry has been combined with hunting. Falconers consider sage-grouse to be one of the most difficult prey species to catch and consider them a trophy. In 2003, Idaho had 73 licensed falconers of which approximately 15 hunted sage-grouse. Only seven or fewer falconers are believed to hunt sage-grouse more than seven days per year. During the 1980s, IDFG conducted an annual harvest survey of falconers. Because of the small take of quarry by falconry methods, this survey was deemed unnecessary and subsequently discontinued. Based on the small number of falconers that pursue sage-grouse in Idaho, the annual take is believed to be fewer than 100 grouse statewide.

Another potential issue associated with falconry is the possible disturbance of lekking grouse in March. In 1995 at the suggestion of the Idaho Falconers Association, the falconry season for upland game birds, including sage-grouse, was shortened by two weeks to March 15 to minimize any disturbance to sage-grouse near leks. Most sage-grouse breeding occurs after that date. Hunting winter flocks of grouse has not been considered a problem since sage-grouse survival during winter is typically high, and low numbers of falconers pursue the species. If sage-grouse numbers demonstrate a significant decline, the falconry pursuit of the species will need to be readdressed. Removing falconry hunting during the winter season would be the first obvious action. Under current regulations, if areas are closed to firearms hunting, the falconry season is also closed.

4.3.17.2 Summary of key conservation issues

- **Need for better hunter effort and success information:** While current Idaho sage-grouse seasons and bag-limits are generally conservative, there is some uncertainty about the timing and impacts of hunter harvest especially on smaller or isolated populations.

- **Need for juvenile production data:** While wing barrels and hunter check stations are currently operated in many strategic locations, not all hunters encounter check stations or barrels and check stations are generally run only during opening weekend. A higher proportion of wings need to be collected and existing wing data are in need of more careful analysis.

- **Need for season and harvest criteria:** As mentioned previously, current seasons and bag-limits for sage-grouse are conservative, but establishing uniform criteria or "triggers" for change will help ensure consistency in approach across the state.

4.3.17.2.1 Hunting season and bag-limit guidelines

Table 4-14 outlines hunting season and bag-limit guidelines, these are referenced in the following conservation measures.

Table 4-14 Hunting season and bag-limit guidelines for sage-grouse populations

Option	3-year running average of lek counts	Days	Daily Bag
Closed	• Less than 100 males observed • Lek counts are less than 50% of 1996-2000 average counts • Lek data not gathered for population	0	0
Restrictive	• Lek counts are between 50% and 150% of the 1996-2000 average.	7	1
Standard	• Lek counts exceed 150% of the 1996-2000 average.	23	2

4.3.17.3 Sport hunting conservation measures

Goal: Manage hunting to support the increase of sage-grouse populations in Idaho and for the sustainability of smaller, more isolated populations that may be more vulnerable to overharvest.

Issue Addressed	Rationale	Conservation Measure(s)
Need for better hunter effort and success information	To ensure seasons and bag-limits are set using the best-available information and are consistent with ensuring sustainability of sage-grouse	1. Require a special permit to hunt sage-grouse in Idaho to allow for efficient identification and sampling of sage-grouse hunters. 2. Conduct an annual telephone survey in order to contact adequate numbers of sage-grouse hunters to allow for reliable statewide and local harvest estimates.

Issue Addressed	Rationale	Conservation Measure(s)
	populations in Idaho.	3. Evaluate accuracy of current harvest estimate data and implement needed changes. 4. Consider the feasibility and potential value of implementing a permit system with mandatory reporting by all hunters.
Need for juvenile production data.	Juvenile production data are crucial to sage-grouse management and wing collection from hunters is currently the only feasible way to collect these data.	1. Conduct opening weekend hunter check stations at strategic locations statewide (Figure 4-16) to collect harvest information and wings from harvested birds. 2. Place wing barrels at strategic locations to increase the sample of wings from harvested birds. 3. Send voluntary wing envelopes to some Idaho sage-grouse hunters before the hunting season to test whether voluntary return of wings can increase the proportion of wings collected from harvested birds. 4. Annually analyze all sage-grouse wings collected to determine age, sex, and molt pattern of harvested birds. 5. Analyze existing wing data to determine the differences in sex and age of the harvest during the opening weekend, compared to later in the season, and summarize other long-term trends.
Need for season and harvest criteria.	Uniform criteria will ensure seasons and bag-limits are established using a consistent process.	1. Identify sage-grouse populations where overharvest is a risk because of (1) isolated or fragmented habitat, or (2) small numbers of birds. Develop appropriate 2006 hunting season recommendations to reduce risk. 2. The following guidelines should be considered by the Idaho Fish and Game Department when making sage-grouse season recommendations to the Idaho Fish and Game Commission: A. Do not hunt populations where less than 300 birds comprise the breeding population (100 or less males counted on leks). All populations geographically isolated by more than 15 miles will be considered separate populations unless specific data demonstrate otherwise. B. Restrict the hunting season if data indicate harvest of over 10% of the fall population for more than one year.

Issue Addressed	Rationale	Conservation Measure(s)
		C. Use the criteria identified in Table 4-14 when setting hunting seasons for each population. LWGs should evaluate how well these guidelines apply to their areas and provide recommendations to the IDFG by May 1, of each year.

Research, monitoring or evaluation needs: Complete geographic delineation of sage-grouse populations. Conduct monitoring activities to refine understanding of harvest effects on populations, age, and sex-classes. Monitor impact of spring hunting on leks.

4.3.18 Mines, landfills, and gravel pits

4.3.18.1 Threat summary and background

Surface mining of any mineral resource, including gravel, will result in direct habitat loss for sage-grouse if the mining occurs in occupied sagebrush habitats (USDI-FWS 2005). Broad-scale graphics prepared by Connelly et al. (2004) indicate a clustering of landfills associated with the East, West, and South Magic Valley; Upper Snake; and Challis SGPAs. The extent and distribution of mines and gravel pits was neither quantified nor mapped for this plan due to limited available information. LWGs are encouraged to do so in the development of their plans, to the extent that these factors are of concern locally.

4.3.18.2 Summary of key conservation issues

- **Habitat loss:** Mines, landfills, and gravel pits, by their nature, result in direct habitat loss and fragmentation. Indirect effects, such as establishment of invasive plants may occur in disturbed areas.

- **Disturbance to important seasonal habitats:** Human activity and noise associated with machinery or heavy equipment in proximity to occupied leks or other important seasonal habitats may disturb sage-grouse.

- **Predation:** Landfills can potentially facilitate predator and corvid (crows, ravens, and related) movements (Connelly et al. 2004). Infrastructure associated with mines or landfills may also facilitate avian predation (See Predation Section 4.3.12 and Infrastructure Section 4.3.2 for additional discussion).

4.3.18.3 Mines, landfills, and gravel pits, conservation measure

Goal: Design and operate mines, landfills and gravel pits in a manner that minimizes or reduces habitat loss or disturbance to sage-grouse.

Issue Addressed	Rationale	Conservation Measure(s)
Habitat loss	The footprint associated with mines, gravel pits and landfills results in habitat loss until such	1. Discourage the establishment of new mines, landfills or gravel pits within sage-grouse breeding or winter habitat. Where possible, avoid occupied leks by at least 3.2 km (2 miles) (adopted from Connelly et al. 200*b*, and Stinson et al. 2004).

Issue Addressed	Rationale	Conservation Measure(s)
	areas are suitably rehabilitated.	2. If the placement of new mines, gravel pits, and landfills in or near breeding habitat is unavoidable, ensure that reclamation plans incorporate the appropriate seed mix and seeding technology to restore suitable breeding habitat characteristics. 3. During activities associated with the exploration, operation, and maintenance of mines, gravel pits, or landfills, ensure that adequate measures are implemented to control invasive plant species. 4. Ensure adequate weed control measures are implemented during the life of the operation. 5. Off-site mitigation should be employed to offset unavoidable alteration and losses of sage-grouse habitat. Off-site mitigation should focus on acquiring, restoring, or improving habitat within or adjacent to occupied habitats and ideally should be designed to complement local sage-grouse conservation priorities.
Disturbance to important seasonal habitats	Activity associated with mines, gravel pits and landfills have the potential to disturb sage-grouse.	1. Apply seasonal-use restrictions (see Human Disturbance Section 4.3.5.) on activities associated with the exploration, operations, and maintenance of mines, gravel pits, or landfills, including those associated with supporting infrastructure.
Predation	Landfills have been associated with increased presence of corvids	See Predation Section 4.3.12.

Research, monitoring or evaluation needs: Improve upon and standardize disturbance buffers. Monitor the effectiveness of recommended disturbance buffers.

4.3.19 Falconry

4.3.19.1 Threat summary and background

The discussion of falconry was combined with hunting in Section 4.3.17. No unique falconry conservation measures were identified.

Chapter 5 – Research, Monitoring and Evaluation

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5 Research, Monitoring and Evaluation

The following chapter includes a discussion of research, monitoring and evaluation needs; guidelines and protocols for sage-grouse population monitoring; guidelines and protocols for sage-grouse habitat evaluation and monitoring and; related adaptive management recommendations. Since this Plan is a living document, users should check the web site at http://fishandgame.idaho.gov/cms/hunt/grouse/ periodically for updates to protocols and other pertinent information.

5.1 Research, monitoring and evaluation needs

Although a great deal is known about sage-grouse ecology and habitat, additional research is needed in order to better understand the range of factors that affect sage-grouse populations, sage-grouse habitat, and the relationship between them. Research is also needed to identify better ways of addressing both population and habitat needs. Additional evaluation and monitoring activities are essential to recognizing and understanding population and habitat trends. Equally important, monitoring and evaluation are crucial to determining the effectiveness of conservation measures and, if appropriate, adjusting or otherwise changing those measures. For these reasons it is particularly important that monitoring and evaluation follow standardized and accepted procedures and protocols wherever they are available.

5.1.1 Summary of needs by threat category

The following section presents a summary of needed research, monitoring and evaluation relative to sage-grouse. Research, monitoring and evaluation needs were presented at the end of each set of conservation measures in Chapter 4 in order make clear the potential uncertainties associated with identifying conservation actions in some cases, to illustrate the limitations associated with conservation actions in other cases, and to underscore the importance of monitoring and evaluation in relationship to most conservation measures. However, they are presented again here as a consolidated unit, for the convenience of those using this document, and in particular, to facilitate planning and budgeting by the primary agencies who are likely to coordinate and fund research, monitoring and evaluation activities.

Research, monitoring and evaluation takes place at multiple spatial and temporal scales. Much, although not all, of the research, monitoring and evaluation needs

identified in the following discussion would occur at the mid- or fine-scale (e.g., SGPA or project scale).

5.1.1.1 Wildfire

- Identify and prioritize specific areas for habitat restoration and fuels modification (e.g., cheatgrass).
- Identify and prioritize areas bordering roads, railroads, farmlands or other areas where cheatgrass or other vegetation poses a high fire risk.
- Develop research methods to improve the establishment and survival of sagebrush seeding efforts.
- Expand efforts to improve the commercial supply of native grasses and forbs suitable for Idaho rangelands.

5.1.1.2 Infrastructure

- Research and monitoring of the effects of wind energy development in sage-grouse habitats with respect to sage-grouse survival, habitat-use and behavior including: abandonment of leks, nesting, brood rearing or winter habitat and the distance from the wind turbines that effects are experienced.
- Of additional interest are the effects of low frequency noise, shadow flicker, presence of tall structures etc.
- Map and quantify secondary and other roads (e.g., paved county, gravel, two-tracks), smaller power distribution lines (<138 kv), telephone lines in SGPAs. Identify specific potential problem areas.
- Identify utility, railroad, road rights of way where invasive plants increase fire risk.
- Research or model the synergistic effects of multiple infrastructure features on sage-grouse survival, habitat use, and behavior.
- Document the incidence and extent of avian predation on sage-grouse nest success, juvenile and adult survival in areas with extensive infrastructure and areas without extensive infrastructure.

- Evaluate sage-grouse response to new and existing power lines as associated with habitat conditions and avian predator densities.

5.1.1.3 Annual Grassland

- Cooperate with the Great Basin Restoration Initiative research projects. This need is also closely linked with research needs associated with climate change.

- Develop a consistent approach for monitoring, evaluating and reporting restoration efforts.

5.1.1.4 Livestock impacts

- Identify the impacts of livestock management (systems and individual practices) on sage-grouse populations, and habitat.

- Monitoring and evaluation is also necessary to better identify and determine the impacts of current grazing management practices on sage-grouse populations, and habitat.

- Document the extent of sage-grouse collision with fences and conduct effectiveness monitoring of flagged or tagged fences.

5.1.1.5 Human disturbance

- Evaluation is needed to document areas where general recreation, and especially, OHV activity may be causing unacceptable disturbances to leks or damage to important seasonal habitats and to aid in the planning or zoning of trails and closure restrictions. Coordination with the Rangewide Conservation Strategy team in developing or refining suggested disturbance buffers is recommended.

- Identify and map areas where potential conflicts may be occurring with human activities related to sheep bedding and leks.

5.1.1.6 West Nile Virus

- Continued testing for immunity.
- Research and testing of potential conservation measures.

5.1.1.7 Prescribed Fire (and sagebrush control)

- Develop a more effective and consistent approach to periodic mapping and classification of sagebrush habitats and cover classes using remote imagery.
- Research sage-grouse response to prescribed fire in the Mountain Big Sagebrush ecosystem.

5.1.1.8 Seeded perennial grassland

- Cooperate with the Great Basin Restoration Initiative research projects.
- Develop a consistent approach for monitoring, evaluating and reporting restoration efforts.

5.1.1.9 Climate change

- Define the capability of ecosystems and vegetation communities to withstand stress and/or disturbance and maintain capability of full recovery.
- Develop high quality, consistent, and accessible soil and vegetation data and models that describe how changes occur in response to stress and disturbance.
- Develop a system that identifies the effects of global change in the very early stages and identifies appropriate management responses.
- Develop new concepts of landscape scale management of rangelands to provide for adaptive management in response to climate change.
- Develop monitoring systems that track and predict how changes in land use and cover affect ecosystem function across spatial scales on rangelands.

- Acquire quantitative knowledge of ecological thresholds, indicators of change, and key decision points in the framework of comprehensive monitoring systems.

- Improve the commercial availability and supply of native grasses and forbs suitable for restoration in arid and semi-arid environments.

5.1.1.10 Conifer encroachment

- Document and refine our understanding of how the reduction of conifer encroachment affects sage grouse populations or lek attendance.

5.1.1.11 Isolated populations

- Develop a more effective approach to determine sage-grouse populations in isolated areas.

5.1.1.12 Predation

- Research, monitoring and evaluation activities to investigate: the behavior of predator species, the intra- and inter-specific relationships of predator populations, the impact of predators and other mortality factors on specific sage-grouse populations of concern, and on sex/age classes.

- Develop better methodologies to assist in identification of predator species linked to sage-grouse predation.

- Determine the factors that affect habitat quality as it relates to the level of predation.

- Determine the effect of habitat fragmentation as it relates to the level of predation.

- Experimentally implement and evaluate predator control measures in areas where predation is suspected to be limiting sage-grouse, to gain a greater understanding of the effects of this management approach on sage-grouse, specific predators, and the relationship between predator species.

5.1.1.13 Urban/exurban development

- Identify parcels of private land suitable as sage-grouse habitat or other sagebrush habitat values that are susceptible to loss to development or uses related to new developments

5.1.1.14 Sagebrush control

- See discussion in prescribed fire Section 5.1.1.7.

5.1.1.15 Insecticides

- Document mortalities of sage-grouse resulting from pesticide-use to improve our understanding of the extent of this threat.
- Monitor the impacts of Mormon cricket and rangeland grasshopper control efforts on sage-grouse food (insect) availability in control versus treatment areas.
- Monitor the effects of Mormon cricket and rangeland grasshopper control with respect to herbaceous and shrub cover in treated and untreated areas.

5.1.1.16 Agricultural expansion

- Sagebrush communities and potential restoration areas that are susceptible to agricultural development should be identified for potential land exchange, conservation easements or related actions.
- Document and report sagebrush acreage converted to agriculture at periodic intervals (to be determined) by county.

5.1.1.17 Sport hunting

- Identify all sage-grouse sub-populations to better understand the potential impacts of hunting.
- Conduct monitoring activities to refine our understanding of harvest effects on populations, age, and sex-classes.

- Monitor impact of spring hunting on leks.

5.1.1.18 Mines, landfills, and gravel pits

- Improve upon and standardize disturbance buffers.
- Monitor the effectiveness of recommended disturbance buffers.

5.1.1.19 Falconry

- See hunting Section 5.1.1.17.

5.1.2 Data gaps identified by U.S. Fish and Wildlife Service

In the discussion of the factors contributing to the greater sage-grouse not warranted Finding, participants in the USFWS structured range-wide science panel identified a number of data gaps that if resolved, could reduce uncertainty in their assessment of the likelihood of extinction within a certain time frame or even change their estimates (USDI-FWS 2005).

This information is included in this Plan because it provides an important window into some of the uncertainties and research, monitoring and evaluation needs that exist at the broad-scale (e.g., state or range-wide) and that might factor into future decisions regarding potential listing of the species.

The areas of uncertainty identified by the USFWS experts included:

- Systematic (e.g., species, subspecies) relationships among various grouse species;
- Underlying mechanisms by which sage-grouse populations respond to habitat changes;
- How to scale grouse habitat preference up to the level at which federal land is managed;
- Lack of studies across the range limits inferences;

- Effects of invasive plants;
- Application of grazing techniques to favor sagebrush habitat;
- Underutilization of the case study approach for sage-grouse management;
- Future gas and oil development impacts;
- Future advances in horticulture and fire suppression;
- The role of crested wheatgrass in sagebrush management; and
- The effectiveness of USDA Conservation Reserve Program or other easement and incentive programs.

5.2 Sage-grouse population monitoring

5.2.1 Monitoring breeding populations

Sage-grouse gather on traditional display areas called leks each spring that allow wildlife managers to track breeding populations by counting males associated with these leks. However, lek locations must be documented before a monitoring program is developed. A recent report on sage-grouse habitat and population monitoring (Connelly et al. 2003*b*) provides information on locating leks from the air and ground. Much of the sage-grouse habitat in southern Idaho has been searched for leks over the past 10-15 years. The identification of lek locations should be an ongoing task because some areas may develop breeding habitat (e.g., recovery of a burned area) and other areas may be altered by vegetative manipulation (e.g., sagebrush control projects or a change in grazing) or construction of various structures (e.g., power lines, wind turbines).

Lek counts have been widely used in Idaho and other western states to track sage-grouse breeding populations. Male sage-grouse are counted on 1 or more leks in a particular area using accepted protocols (see below). However, leks may be widely separated and such counts are not used to assess a single breeding population. Changes in lek attendance may be due to birds moving to other leks (fire) or disturbance (golden eagle, sheep camp, etc.) rather than an actual change in population. Unless all leks are counted in a given area, there is no means of assessing the cause of the change in lek attendance, and the lek count technique may produce erroneous results. Lek counts do serve another purpose, however, in that they provide

important information to land managers as to the presence of occupied or unoccupied leks, regardless of value for trend analysis.

To overcome some of the problems associated with a lek count, a group of leks that are relatively close and represent part or all of a single breeding population are counted together (Connelly et al. 2003*b*) to monitor trend. This approach, termed a lek route, facilitates repetition by different observers, increases the likelihood of recording new or satellite leks, and helps to account for birds moving to other nearby leks (Connelly et al. 2003*b*). Lek routes should be established so that all leks along the route can be counted within 1.5 hours.

Due to funding and manpower limitations, sampling intensity (e.g., the number of lek routes that should be run in a given year in a given area) will vary across the state. The minimum number of lek routes run in a planning area will vary depending on size of the area and accessibility. Of the 13 planning areas currently identified, two (15%) have no lek routes while one planning area has 13 (Table 5-1). A suggested minimum number of primary lek routes for each planning unit and an overall sampling strategy are provided in Table 5-1. Final lek monitoring goals will be determined by IDFG Regions by December 31, 2006. Generally, lek routes should be well distributed throughout a planning unit and should sample all or most major known breeding populations. Secondary routes should be used to support and enhance data on breeding populations, or track changes in habitats that are being rehabilitated. Secondary routes should be run a minimum of every four years. This approach should stabilize annual workloads of management biologists while still maintaining a quality database.

Table 5-1 Minimum number of lek routes suggested for each planning unit and an overall sampling strategy for monitoring breeding populations.

Planning unit	Current number of routes	Minimum number of primary routes suggested	Potential secondary routes
Big Desert	5[1]	5	3
Challis	5	4	1
Curlew	2	2	0
East Idaho Uplands	0	2	0
East Magic Valley	4	2	2
Jarbidge	1	1	0
Mountain Home	0	1	0
Owyhee	5[2]	6	3
Shoshone Basin	1	1	0
South Magic Valley	1	2	0
Upper Snake	13	8	5
West Central	4	1	3
West Magic Valley	3	2	1
Total	44	37	18

For effective and consistent monitoring of sage-grouse breeding population trends in Idaho, IDFG has adopted a standardized methodology for conducting lek routes, summarized below. This protocol will be employed by all individuals including professional wildlife biologists, technicians, volunteers, or others assisting with population monitoring. Document lek survey data, as appropriate, on the standardized forms provided in Appendix I. The "Sage-grouse Lek Survey" form is recommended for use in documenting new leks, or for monitoring individual leks not associated with an established lek route. The "Lek Route Survey" form should be used when running lek routes.

[1] Two routes (INL and Tractor Flats) represent Big Desert populations but are presently included in the Upper Snake SGPA totals.

[2] At least two routes appear to be lek counts. These could be continued as secondary routes but should not be included as lek routes.

5.2.1.1 General instructions for conducting a lek route

1. All new lek route participants must take lek route training available at IDFG regional offices.

2. Run each route four times per spring (four replicates for each route). This will ensure that peak male attendance is encountered at some point during the 4 route replicates.

3. All leks along a route during a particular replicate must be censused on the same morning.

4. Run each lek route from ½ hour before sunrise to one hour after sunrise.

5. All four route replicates should be run by the same observer.

6. Space route replicates roughly ten days apart.

7. Begin March 25 and run through April 30 for low elevation areas.

8. Begin April 5 and run through May 10 for high elevation areas.

9. Conduct lek routes only during good weather. Clear to partly cloudy, winds <10 knots (<12 mi) per hour).

10. Drive <25 mph along route between leks.

11. Count all males observed along the lek route and all males and females at a particular lek.

12. If weather conditions deteriorate outside the accepted parameters during the running of a lek route, the route should nonetheless be completed that day if possible, but subsequently run again in its entirety under acceptable weather conditions. While data from the initial attempt would not be useable for trend monitoring purposes, they may nonetheless be of some value in documenting occupancy of certain leks, especially if for some reason the route cannot be re-run that year.

13. Submit completed lek route forms to the appropriate regional IDFG contact by June 1 of each year.

5.2.1.2 Instructions for monitoring a specific lek

1. Locate a spot that provides good visibility of the entire lek. Two or three observation points may be necessary for a large lek.

2. If a lek does not appear to be occupied, turn off the engine, step out of the vehicle and listen for displaying birds.

3. Record the time the count begins and ends as well as other pertinent information on the standardized form (observer name, lek name/number, weather conditions, etc.). Do not record data on scrap paper or non-standardized forms. This will ensure that all participants consistently account for all necessary information.

4. First, count birds from right to left, wait 1-2 minutes. Second, count birds from left to right, wait 1-2 minutes. Finally, count birds from right to left again.

5. Record the highest number of males and females separately. If no birds are present, it is very important that you record a zero. Do not leave a space blank.

6. Proceed to the next lek and repeat steps 1-5. Watch carefully for new leks. If new leks are encountered along the way, stop and do a count following steps 1-5. Make a note on the form regarding the new lek.

7. Obtain GPS positions of all lek locations if this has not been done previously. Obtain a new GPS position if a lek moves greater than 0.25 mile.

8. If a new lek has been discovered, be certain to coordinate with the appropriate IDFG wildlife manager or data steward in assigning the appropriate lek identification number to the new lek.

5.2.1.3 Breeding population data administration

The Idaho sage-grouse lek database will be maintained by the IDFG Conservation Data Center. Data will be made available to cooperating agency biologists and LWGs.

5.2.2 Production monitoring

Currently, the only practical way to monitor sage-grouse chick production is by classifying wings from hunter-harvested birds. The wing from a sage-grouse can provide information on the age (juvenile, yearling, or adult), gender, and reproductive status (for yearling and adult females successful or unsuccessful at nesting). Wings are collected at hunter check stations and from wing barrels distributed throughout southern Idaho. In late fall or early winter, the wings are classified by IDFG biologists and other trained volunteers during annual "wing bees". Future wing bees will provide opportunities for participation by members of LWGs. Data collected during the wing bees is recorded by harvest unit, however, data can also be grouped by Sage-grouse Planning Areas.

5.2.3 Harvest monitoring

An annual telephone survey of sage-grouse hunters will be used to estimate harvest, number of hunters, effort, and birds per hunter. Check stations will be used to monitor hunter success (birds per hunter and hours per bird) and trends in hunting pressure. Regional IDFG personnel will advise LWGs of planned sage-grouse check stations and participation by LWG members will be encouraged. Additionally, wing barrels will provide an index to harvest although their primary purpose is to increase samples of wings for estimating production.

5.2.4 The future of population monitoring

Idaho and other sage-grouse states currently monitor sage-grouse populations in a generally standardized manner within state boundaries. However, the aggregation and analysis of population data at scales encompassing multiple states has been problematic, due to differing protocols or standards for data collection. In an effort to resolve this issue, sage-grouse biologists and statisticians convened in Pocatello, Idaho, May 17-18, 2005 to explore options to improving methodologies for use at broader scale. In general, participants agreed there is a compelling need for standardization of population monitoring protocols and standards rangewide, and a need for a hierarchical sampling approach that would facilitate the inference of population status and trends across geographic areas and multiple scales. Idaho sage-grouse researchers are at the forefront of this important issue, as new approaches to monitoring populations and managing data are developed, Idaho's existing monitoring protocols will be modified as appropriate.

The National Wildlife Federation in Montana has developed an "Adopt-a-Lek" Program to encourage private landowners, sportsmen and others to assist agencies in monitoring leks. IDFG will explore this concept and develop a recommendation by December 31, 2006.

5.2.5 Summary of SGPA population monitoring goals

Following is a summary of suggested population monitoring goals by SGPA, based on the current status of routes, knowledge of data gaps and local conditions.

5.2.5.1 Big Desert SGPA

- Continue to monitor existing lek routes.
- Periodically check for activity along 2 historical routes.

5.2.5.2 Challis SGPA

- Continue to monitor as many leks as possible in the Lemhi and Pahsimeroi drainages. Expand efforts in other areas throughout the planning area (Challis, Morgan and Ellis Creek) through ground counts and aerial surveys.
- Multiple years of aerial surveys may need to be conducted to determine lek activity (especially in high snow years).

5.2.5.3 Curlew SGPA

- Maintain lek route counts and increase monitoring efforts through aerial surveys and ground counts.
- Work with private landowners to obtain access to private lands, to enhance lek survey and monitoring efforts.

5.2.5.4 East Idaho Uplands SGPA

- Increase efforts to identify active leks in Caribou, Bingham, and Power (Deep Creek Mountains) Counties through ground counts and aerial surveys.

- Develop lek routes or trend counts to identify changes in activity.

5.2.5.5 East Magic Valley SGPA

- Continue monitoring current lek routes for long-term trends.

5.2.5.6 Jarbidge SGPA

- Maintain lek route counts and increase monitoring efforts in the Inside Desert and Grassy Hills area through aerial surveys and ground counts.

5.2.5.7 Mountain Home SGPA

- Increase lek counts through ground counts and aerial surveys.

5.2.5.8 Owyhee SGPA

- Continue to increase monitoring efforts through aerial surveys and ground counts.
- Develop additional methods to count leks in isolated areas such as infrared sensing.

5.2.5.9 Shoshone Basin SGPA

- Continue to monitor all leks along the lek route for changes in population trends.

5.2.5.10 South Magic Valley SGPA

- Increase efforts to identify active leks through ground counts and aerial surveys, and create new lek routes or trend counts on individual leks.

5.2.5.11 Upper Snake SGPA

- Continue to monitor lek routes for long-term trends, modify routes counted to maximize efficiency (if there are some routes that cannot be counted annually due to lack of personnel, consider counting every 5 years to determine activity). Expand efforts in the Upper Big Lost drainage.

5.2.5.12 West Central SGPA

- Maintain or increase current monitoring efforts through ground counts and aerial surveys.

- Need to work closely with private landowners to obtain access on private lands, to enhance lek survey and monitoring efforts.

5.2.5.13 West Magic Valley SGPA

- Continue to conduct lek route counts to identify changes in population trends.

5.3 Sage-grouse habitat evaluation and monitoring

The evaluation and monitoring of sage-grouse habitats and selected threats are crucial components in the implementation of this Plan. Standardized approaches for the collection and aggregation of spatial and tabular data across multiple scales are presented in this chapter along with specific tasks, timelines, and responsible parties. In some cases processes or protocols still need to be developed; in these cases suggested tasks and timelines are identified to facilitate further action.

The general approach presented in this chapter is to address monitoring needs and tasks first at the broad-scale (e.g., state of Idaho; 1:500,000 scale) and mid-scale (e.g., Sage-grouse Planning Area; 1:100,000 scale), followed by fine-scale (e.g., watershed, specific habitat restoration project; 1:24,000 USGS quad scale). In general, tasks related to data acquisition and management for broad and mid-scales will be accomplished at the state-office level, and tasks at the fine scale will be the responsibility of land-management agency field offices and the IDFG Regional-level offices. Private landowners who wish to contribute information are encouraged to work closely with their respective IDFG Region and/or NRCS offices. Because of the hierarchical, multi-scale nature of habitat data, it is essential for agency field and

state office level entities to coordinate closely. More specific discussion and details are provided in the following sections.

5.3.1 Broad- and mid-scale monitoring

5.3.1.1 Idaho sage-grouse habitat planning map

The monitoring of trends in acreage of Key Habitat, Perennial Grasslands, Annual Grasslands and Conifer Encroachment Areas at the mid- and broad scales is crucial in determining progress toward meeting the goals and objectives in the Idaho Sage-grouse Conservation Plan. To that end, the Idaho Sage-grouse Habitat Planning Map will be updated annually, based on the past year's wildfire, habitat restoration, sagebrush/fuels management and related activities occurring on federal, state and private (volunteer landowner) lands. Updates will be disseminated and/or made available to Local Working Groups (LWGs) and partners. In addition, non-sensitive data will be made available to the public through the Internet. See Section 5.3.4.2 for additional discussion. As mapping technology and the resolution and accuracy of digital map products improve, they will be considered for use in refining or replacing the habitat planning map.

The Sage-grouse Advisory Committee (SAC) will establish a SAC Technical Assistance Team (TAT) by August 31, 2006, to facilitate the characterization, tracking and reporting of general status and trends in sage-grouse habitat characteristics and populations statewide. The SAC- TAT will include representatives from the Bureau of Land Management, U.S. Forest Service, Idaho Department of Fish and Game, Idaho Department of Lands, Idaho Department of Agriculture, and NRCS. Tasks assigned to the SAC TAT will include:

- Develop and disseminate a template for LWG annual accomplishment reports by October 31, 2006. Establish a database and/or spreadsheet to summarize habitat accomplishments from LWG annual reports, and habitat accomplishments from other agency and private projects by December 31, 2006. Also develop a format for producing a summary suitable for a statewide progress report.

- Serve as an information conduit between LWGs, SAC, and agencies, to provide habitat and population data as needed, and to ensure that information needed for annual updates to the Sage-grouse Habitat Planning Map and related reports is acquired in a timely manner. Note: site-specific fine-scale data will be maintained by the individual agencies.

- Review adequacy of 2005 USGS Shrubmap or other vegetation map products, by December 31, 2007 to help refine or replace the Sage-grouse Habitat Planning Map.

5.3.1.2 Habitat fragmentation monitoring

Graphics of selected habitat fragmentation metrics are illustrated in Chapter 3. These products were generated via GIS and FRAGSTATS (a computer program for analyzing fragmentation), based on the 2005 USGS Shrubmap digital landcover dataset and reflect conditions during approximately 1999-2003. As partnerships are developed and/or as new, updated imagery becomes available (e.g., approximately every 5-10 years), the status and/or trends in habitat fragmentation will be re-evaluated or refined.

- SAC-TAT will coordinate with USGS, Universities and other appropriate partners in further evaluating landscape and habitat fragmentation at multiple scales. Since technology and analytical approaches are anticipated to change, and since approaches to quantifying or modeling fragmentation vary depending on the metric, specific methods or software are not prescribed here.

5.3.1.3 Infrastructure monitoring

Baseline infrastructure, maps and statistics for major paved roads (state, federal, interstate), major power lines (>138 kv), active railroads, oil/gas pipelines, communications towers, and wind energy development/monitoring sites, by SGPA, have been incorporated into Chapter 4 using data available as of late 2004. Infrastructure metrics, including linear distance (miles), linear density (e.g., feet/acre), acres of buffer, and percentage of SGPA potentially influenced by buffers have been calculated for each SGPA but periodic updates will be necessary due to anticipated increases of these features on the landscape. Infrastructure data compiled at the local level will be aggregated to the broad- and mid-scale as needed (see Section 5.3.3 for additional discussion).

5.3.2 Fine-scale monitoring

5.3.2.1 Monitoring sage-grouse habitat characteristics

The monitoring of the status and trend of resource conditions and sage-grouse habitat characteristics at the fine-scale is particularly important since many aspects of

habitat-selection by grouse occur at this scale (e.g., nest site selection), and many land-use decisions and habitat effects also occur at the fine-scale. Fine-scale data can also be valuable in helping summarize our knowledge of conditions across broader landscapes, and is essential for accurately describing seasonal habitats.

There currently is no universally adopted methodology or process in place for evaluating and monitoring habitat characteristics across agency jurisdictional boundaries. While some land-management agencies (BLM, USFS, IDL, IDFG-Wildlife Management Areas) have varying protocols or partnering capabilities in place, the resulting data are not readily comparable or consistently available. Moreover, in many cases, existing data are not readily accessible for broader-scale applications or reporting. The standardization of field data collection protocols and/or the establishment of a centralized data storage system would facilitate analyses and foster closer coordination.

A national interagency group, the Sage-grouse Habitat Assessment Framework Technical Working Group, has been formed to develop a standardized approach for measuring greater sage-grouse habitat characteristics. Until this or a similar standardized approach for assessing habitats across jurisdictional boundaries has been adopted:

- Land management agencies will use existing habitat evaluation approaches, subject to modification as deemed appropriate by the respective agencies; and

- Other partners are encouraged to use Monitoring of Greater Sage-grouse Habitats and Populations (Connelly et al. 2003*b,* see Appendix H).

Regardless of the specific method used to collect habitat data, when interpreting the data, other information such as evaluations of rangeland health, long-term vegetation trend monitoring data, soil and ecological site information, aerial photographs, satellite imagery, and local knowledge of land management practices, should also be taken into consideration, to the extent such information is pertinent and available. It is also important that the interpretation of habitat data be made in the context of historic and recent disturbance events and recent weather patterns, such as drought or wet-cycles. For example, grass and forb cover can increase or decrease measurably depending on seasonal moisture conditions, irrespective of current management.

The following sections and accompanying tables describe sage-grouse habitat preferences based on research rangewide. It is important to note that the vegetative preferences described, such as height and canopy coverage, are likely to occur as different-sized patches in sagebrush/grassland communities. Specific measurements, such as grass canopy height at nest sites, do not imply a uniform landscape-wide measurement, but instead are a microsite measurement of vegetation at a specific site.

For instance, within a functional sagebrush community, under average growing conditions, the mosaic of varying vegetative characteristics should provide for many potential nesting sites across the landscape. If not, nesting cover could be a limiting factor, which may show up in the form of lower rates of nest success (Connelly et al. 2000*b*). Also, in some parts of Idaho, vegetation may not be capable of achieving the desired height or cover characteristics. Connelly et al. (2000*b*) suggested, "…in all these cases, local biologists and range ecologists should develop height and cover requirements that are reasonable and ecologically defensible."

In describing these general habitat characteristics, the intention is to identify habitat needs of sage-grouse and to help managers determine possible limiting factors associated with sagebrush communities. Sage-grouse do not use their habitat randomly, but select habitat based on their needs at a particular time. Similarly, the habitat descriptors that follow cannot be applied randomly. Their application requires discretion and must recognize the natural patchwork of variability that exists in a functional sagebrush community and the potential of the site to produce and maintain wood shrub and herbaceous cover.

5.3.2.2 General sage-grouse habitat use periods

Table 5-2: Generalized habitat use periods and descriptions (see Table 5-3 for fine-scale habitat descriptions)[3]

Habitats	General use period [a]	General description [b]
Breeding	March 1 - June 30	Variety of sagebrush communities in close proximity to big sagebrush communities
Leks	March 1 - May 15	Open areas near sagebrush where males traditionally display and breeding occurs.
Nesting	April 1 - June 15	Primarily big sagebrush communities, 15-25% canopy cover in close proximity to leks. Also includes habitat for pre-laying hens.
Early brood-rearing	From hatch - June 30	Sagebrush communities including low sagebrush in proximity of nest sites.
Summer - Late brood-rearing	July 1 - August 31	Variety of mesic or moist habitats in close proximity to sagebrush communities.
Fall	Sept 1 - Nov 30	Shift from summer habitats to winter habitats with timing variable.
Winter	Dec 1 - Feb 28	Variety of sagebrush communities that have sagebrush exposed over the snow.

5.3.2.2.1 Breeding habitat

The breeding period spans a very important time frame for sage-grouse, from lek attendance, through early brood-rearing. During this period, the hen and chicks are dependent on cover and food that sagebrush communities provide. Generalized habitat indicators for breeding habitat are summarized in Table 5-2.

In many areas, cover and food requirements during this critical period are provided by large expanses of mostly big sagebrush communities. However, in other areas, community mosaics of big and low sagebrush together provide the important life requisites. Often, inclusions or fingers of big sagebrush or other tall-statured sagebrush species (e.g., *A. tripartita*) provide the structure for protective nesting

[3] Information in this table was compiled from Connelly et al. 2000*b*; Connelly et al. 2004; and J. Connelly personal communication October 2004.

[a] Use periods may vary based on elevation, location, and annual weather conditions.

[b] General descriptions are for Idaho statewide; primary vegetation communities may vary based on local conditions and availability.

cover, while the more extensive adjacent low sagebrush communities provide an abundance of forbs and insects.

Average distances between nests and the nearest leks vary from 1.1 to 6.2 km (0.68 to 3.85 miles) (Autenrieth 1981, Wakkinen et al. 1992, Fischer 1994, Hanf et al. 1994, Lyon 2000 cited in Connelly et al. 2000*b*). The distribution of nest sites in relation to leks can vary considerably, complicating efforts to map breeding habitat, and depends on whether populations are migratory or non-migratory, the habitat quality, and whether habitats are continuous or fragmented. Most sage-grouse populations in Idaho are thought to be migratory (Idaho Sage-grouse Science Panel discussion, February 1-2, 2005). For those migratory populations, leks generally are associated with nesting habitats, however, migratory grouse may move more than 18 km (11 miles) from leks to nest sites (Connelly et al. 2000*b*).

Mapping procedure: To provide some level of consistency in approach to initially delineating breeding habitat, use of the following sequential mapping process is suggested (adopted from information provided in Connelly et al. 2000*b*), unless breeding habitat has already been identified locally through research, monitoring of radioed hens or other means. The suggested mapping procedure should also be useful in establishing a baseline for the analysis of the cumulative effects of disturbances (e.g., wildfire), and completed/planned vegetation management projects within SGPAs or other geographic areas. It is important to note that while the term "radius" is used in the mapping protocol, the intent is not to imply that all breeding habitats occur uniformly within a circle around specific leks or that the circle would delineate a rigid boundary. Rather the intent of this approach is to provide a methodology that can be easily used via routine GIS procedures to initially describe a polygon within which breeding habitat likely occurs. By describing "circles" around occupied leks, the resulting irregular polygon, created by overlapping circles (since many leks occur in proximity to each other) should include most of the potential breeding habitat, and thereby provide an area within which further analyses can be completed. Common sense and local site-specific knowledge of habitat conditions, directional movements of sage-grouse, and other factors are important complements to effectively utilizing this methodology.

Step 1 purpose: Identify the initial broad analysis area for the sage-grouse "population" of interest.

<u>Step 1.</u> Select the desired landscape of interest, such as SGPA, appropriate Hydrologic Unit(s) (i.e., HUC), agency administrative unit, or other appropriate geographic area.

Step 2 purpose: Identify the area within which breeding habitat most likely occurs.

Step 2. Acquire the most recent IDFG sage-grouse lek coverage. Using a Geographic Information System (GIS), show all leks. Buffer each occupied lek with the appropriate distance (3.2 km, 5 km, or 18 km radius), depending on the migratory status of the sage-grouse population. (An occupied lek is defined as a lek where at least two or more male sage-grouse have attended in two or more of the previous five years.) This exercise will refine the initial breeding habitat analysis area determined in Step 1, in relation to leks. At this point, it is assumed that, for the population in question, most breeding, nesting and early brood rearing activity will occur in sagebrush communities within this defined area.

Step 3 purpose: Identify areas within the analysis area that have generally suitable sagebrush cover for breeding habitat.

Step 3. Using available vegetation maps, query for sagebrush areas within the analysis area described in Step 2. Ideally, identify areas of 15-25% sagebrush canopy cover. In the absence of recent field-level or other more accurate vegetation maps, it is recommended that the 2005 USGS Shrubmap landcover dataset (http://sagemap.wr.usgs.gov/) be used in the interim, to provide consistency statewide, until such time as Shrubmap is updated, refined or replaced. Sagebrush polygons in Shrubmap reflect areas approximately 10% total shrub cover or greater, with sagebrush being dominant. It may also be useful at this point to combine areas of big sagebrush subspecies and areas of low/black subspecies separately.

Step 4 purpose: Refine the map described in Step 3, based on herbaceous understory conditions.

Step 4. Separately identify areas within the suitable (15-25% canopy cover) sagebrush communities that provide suitable or unsuitable herbaceous understory conditions. This will necessitate additional field-level mapping/verification or use of recent vegetation maps. Areas determined to provide suitable breeding habitat in terms of both sagebrush cover and understory structure and composition should be exempt from vegetation manipulations in most cases. Areas determined to be unsuitable or marginal breeding habitat, based on understory conditions, should be considered for habitat improvement efforts or other management actions, depending on local needs and scale.

Step 5 purpose: Identify areas of marginal (less than 15%) or high (greater than 25%) sagebrush cover within the analysis area.

Step 5. The use of National Agriculture Imagery Program (NAIP) data, aerial photographs, field-level maps or similar products will be necessary, until such time as the resolution of satellite imagery is refined. Areas with marginal sagebrush cover are anticipated to provide suitable breeding habitat sagebrush cover in the future. Areas with sagebrush cover exceeding 25% may warrant consideration for vegetation management actions, depending on local conditions, objectives, and scale.

Step 6 purpose: Identify or refine potential restoration areas within the analysis area.

Step 6. Query for annual grassland, perennial grassland, and conifer encroachment areas. Although the Idaho Sage-grouse habitat Planning Map identifies these areas on a coarse scale, doing so with more refined digital imagery (e.g., 2005 USGS Shrubmap, NAIP, or similar products), or field-level mapping is recommended. In general, when planning and prioritizing areas for sage-grouse breeding habitat improvement or restoration, exclude sites that, due to topographic or other factors, are of questionable value or that place sage-grouse at further risk. Such sites might include (a) areas in excess of 40% slope, (b) areas within deep canyons, (c) areas outside of any SGPA boundary (i.e., not within an Idaho SGPA), (d) areas near human habitation or (e) areas where other factors such as proximity to roads, recreation areas, infrastructure features or other considerations are likely to compromise sage-grouse use.

Step 7 purpose: Model landscape dynamics, vegetation succession or management options.

Step 7. Where vegetation modeling tools and expertise are available, (e.g., LANDFIRE, VDDT-Vegetation Dynamics Development Tool, others), model vegetation changes under different management/treatment scenarios to identify optimal treatment approaches and identify risks.

Table 5-3: General characteristics of sagebrush rangeland needed for productive (suitable) sage-grouse breeding habitat[4]

Habitat features	Habitat indicators	Recommended habitat characteristics	
		Arid sites [c]	Mesic sites[c]
Protective cover	Sagebrush canopy cover	15-25%	15-25%
	Sagebrush height	12-31" (30-80 cm)	16-31" (40-80 cm)
	Sagebrush growth form [a]	Spreading	Spreading
	Perennial grass/forb heights	>7" (>18 cm)	>7" (>18 cm)
	Perennial grass canopy cover	Not specified	≥15%
Protective cover and food	Forb canopy cover	Not specified	≥10%
	Total Grass/forb cover	>=15%	>=25%
Food	Forb availability	Good abundance & availability relative to ecological site potential	Good abundance & availability relative to ecological site potential
Area [b]		>80%	[b]

5.3.2.2.2 Late brood-rearing habitat

Numerous moist or mesic vegetation communities provide late-brood-rearing habitat (Table 5-4). In most areas of Idaho, these habitats are not thought to be limiting for sage-grouse (J. Connelly personal communication 10/2004). However, the distribution of these sites is important, and may change over time due to losses or deterioration as a result of climate change, or development of agriculture, irrigation or hydropower/water sources. Sage-grouse generally will move to higher elevations or

[4] Modified from Connelly et al. 2000*b*.

[a]Sagebrush plants that are more tree or columnar-shaped do not provide the protective cover of sagebrush with a spreading shape. Sagebrush communities with the more columnar shape would require more herbaceous cover to provide good protection for nesting sage-grouse and young broods.

[b] Percentage of seasonal habitat needed with indicated conditions. Connelly et al. 2000b also suggest >80% for mesic areas, but some SAC members believe additional research is needed.

[c] Mesic and arid sites should be defined on a local basis, depending on annual precipitation, herbaceous understory and soil conditions (Tisdale and Hironaka 1981 and Hironaka et al. 1983 cited in Connelly et al. 2000*b*). As a starting point, sites with less than or equal to 12 inches average annual precipitation should be considered arid; and sites greater than 12 inches as mesic.

to wet areas as summer progresses (Schroeder et al. 1999). For some areas, this elevational movement can be fairly dramatic (Connelly et al. 1988, Connelly et al. 2000*b*). For other areas where nesting is occurring at higher elevations or near wet meadow complexes, this movement may be rather limited (Connelly et al. 1988).

Mapping procedure: It is important to delineate those brood-rearing areas that are potentially significant, at the fine-scale. The characteristics presented in Table 5-4 provide general guidelines for productive late brood-rearing habitat.

Several information sources could be helpful for delineating these areas at this scale:

- Observations by local residents, biologists or Local Working Groups
- Historic observation records available in BLM, USFS or state agency files
- National Wetland Inventory (NWI) maps
- Riparian Proper Functioning Condition assessments and maps
- Aerial photography (particularly color infra-red)
- Query for appropriate mesic upland and forb-rich vegetation covertypes, using the 2005 USGS Shrubmap regional landcover dataset (see SAGEMAP website, http://sagemap.wr.usgs.gov/).

Table 5-4: General characteristics of sagebrush rangeland needed for productive late brood-rearing habitat [5]

Habitat features	Habitat indicators	Recommended habitat characteristics [a]	
		Upland sagebrush communities	Riparian and wet meadow communities
Protective cover	Sagebrush canopy cover	10-25%	N/A
	Sagebrush height	16-31" (40-80 cm)	N/A
	Sagebrush proximity		Protective sagebrush cover as described above, under habitat indicators, is within 300 m of riparian or wet meadow feeding area
Protective cover and food	Grass/forb canopy cover	>15%	N/A
Food	Forb availability	Succulent forbs are available during the summer. Generally applies to higher elevations, such as mountain big sagebrush sites.	Riparian and wet meadow conditions are such that succulent forbs are available during the summer

5.3.2.3 Winter habitat

Sagebrush must be exposed above the snow to be available for sage-grouse use, and this situation is most commonly provided at lower-elevation sagebrush areas and on wind-swept ridges. It is important at this scale to identify and map these traditional use areas, particularly those that are crucial habitat for large numbers of birds.

Mapping procedure: Focus on identifying and mapping known sage-grouse winter-use areas based on local knowledge, winter surveys or observations by LWG members, landowners, biologists or others. In the absence of local information, the use of GIS and appropriate spatial data, such as the 2005 USGS Shrubmap regional landcover dataset (http://sagemap.wr.usgs.gov/), may be of help in initially identifying potential wintering areas based on sagebrush cover. However, due to potential local or seasonal variations in weather patterns, snow depth, topography,

[5] Adopted from Connelly et al. *2000b*.

[a] In areas where agricultural fields provide the food resources, the habitat indicators for protective cover also apply.

aspect and the migratory status of the sage-grouse population, on-the ground verification of sage-grouse use of these areas should be completed, especially during winters of above average snow. Determining sage-grouse use during years of above average snow will identify critical wintering areas.

Table 5-5: Characteristics of sagebrush rangeland needed for productive sage-grouse winter habitat [6]

Habitat features	Habitat indicators	Recommended habitat characteristics
Protective cover and food	Sagebrush canopy cover	10-30% exposed above the snow
	Sagebrush height	10-14" (25-35 cm) exposed above the snow

5.3.2.4 Mapping and monitoring of seasonal habitats

The location and status of breeding and winter habitats across Idaho is not well documented. The mapping and evaluation of these habitats will help facilitate conservation planning at the LWG and finer scale.

- Task 1. The IDFG Regions, in cooperation with land-management agency biologists, and LWGs, will delineate all known sage-grouse breeding and winter habitats at 1:100,000 (or 1:24,000 if possible) by December 31, 2007, using the best available information. Areas providing particularly important late-brood rearing habitat (e.g., certain meadows or riparian areas; agricultural-shrubsteppe interfaces where brood use has been documented), should also be delineated. Spatial and tabular data will be maintained and archived by the IDFG. The IDFG Regions will coordinate closely with land-management agencies SAC TAT, and LWGs, as appropriate. The purpose of this mapping effort is to provide a tool to help LWGs and land management agencies in identifying and prioritizing areas for more detailed habitat evaluations or monitoring, fire management planning, and/or restoration efforts.

5.3.2.5 Monitoring selected geographic areas

In the future, certain important areas may warrant more detailed, long-term monitoring. For instance, it may be useful to collect information to address the need for statistically valid rangewide monitoring population and habitat trends, or to research effects of habitat fragmentation, etc. in key areas in Idaho. Such areas may include: (1) Areas of particular interest or concern to LWGs, (2) Habitats closely associated with one or more sage-grouse lek routes of interest, (3) One or more

[6] Adopted from Connelly et al. 2000*b*.

priority SGPAs as identified by the SAC, or (4) Certain unique areas of particular local or regional importance.

- *Task 1.* The concept described above will be evaluated by IDFG Research Biologists and LWGs, as appropriate, by December 31, 2006, with at least partial implementation anticipated during 2007. Sampling methodologies and analytical approaches will be designed in collaboration with a qualified statistician, and in general will likely incorporate stratified random sampling with permanent plots.

5.3.3 Mapping and monitoring projects and infrastructure

The careful documentation of vegetation management and restoration projects, wildfires, infrastructure and other factors affecting sage-grouse habitat is vitally important. Specifically, this information will serve as the foundation for updates to the Idaho Sage-grouse Habitat Planning map, and for tracking progress toward the elimination, reduction or mitigation of threats locally and at broader scales.

- *Task 1.* SAC-TAT and IDFG will coordinate with appropriate agency contacts (e.g. BLM, FS, IDFG, IDL, NRCS) and LWGs to update the statewide sage-grouse habitat planning map annually.
    - The annual statewide map update will be completed and made available by approximately March 1 of each year.

- *Task 2.* The SAC-TAT will coordinate with IDFG to acquire spatial data relative to new infrastructure features (e.g., paved state, federal, interstate roads, major power lines, wind energy development sites, communications towers, oil/gas pipelines, geothermal sites, etc.) as needed.

- *Task 3.* LWGs are encouraged to utilize the baseline infrastructure maps and metrics provided in the Plan to aid in prioritizing threats locally, in the short term. In the longer term, it is recommended that LWGs collaborate with agencies, rural utility companies and other entities or partners in mapping and quantifying infrastructure features not available in the Plan, such as local power distribution lines, minor roads (e.g., gravel, county, 2-track, OHV trails, etc.), or other features to establish a more refined baseline.

5.3.4 Data dissemination and archiving

5.3.4.1 Archiving

The data described above (Sections 5.3.1 through 5.3.3) will be permanently archived, and updated annually, by IDFG.

5.3.4.2 Dissemination

The data described above are generally intended for use by agency specialists, LWGs, or NGO partners, in conservation planning for sage-grouse. However, the data are considered Category 1 public data, and will be made available to the public via the Idaho FGDC Geospatial One Stop Clearinghouse node at the University of Idaho, USGS Sagemap website, and the Department of Interior Geography Network. Private lands information will only be available as public information when individual landowners voluntarily provide information.

5.4 Adaptive management

The utility of this Plan in achieving its stated objectives is largely contingent on the implementation of the various conservation measures in the appropriate place and time, and their subsequent effectiveness. While measures may be implemented with the best of intentions, the success of certain measures is not guaranteed. For example, a restoration seeding may fail, or prove only marginally successful, due to unforeseen influences such as drought, wildfire, rangeland grasshopper outbreaks, or human error. Moreover, some conservation measures may involve habitat restoration actions that will take well over a decade to accomplish.

Given the multitude of temporal and spatial variables, in many cases, determining the specific effects of individual conservation actions on sage-grouse populations will be very difficult. However, over time the knowledge gained by trying to assess the effectiveness of various actions will contribute new knowledge about sage-grouse populations and about the utility of conservation actions.

Adaptive management is a method for examining alternative strategies for meeting measurable biological goals and objectives, and then, if necessary, adjusting future conservation management actions according to what is learned. As knowledge about Idaho sage-grouse populations increases, and as a better understanding of the effectiveness of various conservation measures (at both local and regional scales) is

gained, it will be possible and desirable to review the effectiveness of various actions and adapt those responses where it is deemed appropriate.

The degree to which conservation measures (or strategies) meet their stated objectives can only be determined by monitoring. It is thus the intent of this Plan to ensure that: (1) the implementation of conservation measures be documented by the appropriate agency or landowner, (2) the success or effectiveness of conservation measures be monitored periodically using the most appropriate method, and (3) information exchange occurs between parties to the Plan to facilitate the learning from our various management actions. Suggested processes and mechanisms for documentation and information transfer necessary to implement adaptive management are identified in Table 5-6.

Table 5-6 Process and documentation necessary to implement adaptive management

Action	Responsible Party	Method of Documentation
Implementation of conservation measure	Agency project team leader or landowner	1. Project Completion Report in project file, with "as-built" illustrations, details as appropriate; upward reporting of spatial and tabular data; include in annual LWG report to the SAC.
Measure effectiveness of conservation measure	Agency project team leader or landowner	1. Standardized protocol (e.g., vegetation transect); photographs; narrative write-up. Results placed in permanent project file. Results incorporated into annual LWG report to SAC.
Information transfer	Agency specialists, landowners, LWGs, Research Biologists, and Ecologists	1. Annual reports to the SAC and coordination with SAC TAT. 2. Presentations at professional meetings (e.g., Idaho Chapter Wildlife Society, Society for Range Management, etc.) 3. Publication in peer-reviewed scientific publications or other appropriate venues.

Chapter 6 – Implementation Milestones

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6 Implementation Milestones

The successful implementation of this Plan necessitates that certain important tasks and processes occur in a timely manner. Many sound, proactive activities, such as sage-grouse habitat restoration, wildfire suppression and rehabilitation, restrictive sage-grouse harvests, and control of invasive plant species are already in progress or will be planned on a site-specific basis. Many other important tasks are pending. The purpose of this Chapter is to concisely summarize the latter, and identify responsible parties and target deadlines.

Specific project proposals as developed locally, public education efforts, habitat/population assessment and monitoring efforts, research, and staff participation in Local Working Groups (LWG) will be routinely incorporated into agency annual budgets and work plans, as appropriate, and contingent on funding. Agencies, LWGs and other cooperators are also expected to pursue partnership opportunities, to leverage available funding to the greatest extent possible.

Certain elements of this Plan, including fine-, mid- and broad-scale habitat goals and objectives, habitat and population management conservation measures, LWG processes, and habitat and population monitoring techniques will be implemented immediately, where possible. However, implementation of some measures will occur as they are evaluated and incorporated into other plans or processes. For example, mid-scale habitat objectives described in this Plan may not be consistent with agency Land-Use Plans, necessitating further analysis during scheduled Land-Use Plan revision or amendment processes.

6.1 Local Working Group process related milestones

Category/Task	Responsible Party	Target Deadline
Identify funding needs and funding sources to implement the State Conservation Plan and LWG plans, including support for LWG facilitators.	SAC, cooperating agencies	December 31, 2006, incorporate new facilitators as soon as possible after funding is secured
Existing LWGs with draft plans (Shoshone Basin, Jarbidge), should complete and finalize their plans.	LWGs and facilitators	December 31, 2006
Existing LWGs that currently do not have draft plans (Challis, West Central) should complete and finalize their plans.	LWGs and facilitators	December 31, 2007
Initiate formal LWGs in the South, East and West Magic Valley, Big Desert, East Idaho Uplands and Mountain Home SGPAs. Opportunities may exist for combining some SGPAs into a single LWG, as determined locally.	IDFG Regions	December 31, 2006
LWGs provide annual report to SAC.	LWG facilitators or designated lead	Start December 31, 2006, annually thereafter

6.2 Conservation measure related milestones

Following are specific conservation measure related milestones identified in this Plan. At present this state Plan does not identify specific milestones for a number of the statewide threats including: infrastructure, livestock impacts, human disturbance, West Nile Virus, prescribed fire, seeded perennial grassland, climate change, conifer encroachment, isolated populations, predation, urban/exurban development, sagebrush control, insecticides, agricultural expansion, Mines, landfills, and gravel pits, and falconry.

6.2.1Wildfire

Category/Task	Responsible Party	Target Deadline
Ensure the BLM/FS Fire Management Plans, Fire Management Unit Databases and related tools are updated annually, based on the most recent Sage-Grouse Habitat Planning Map.	BLM, FS	Annual, before the ensuing fire season
Require the washing of the undercarriage of fire vehicles and equipment prior to deployment and prior to demobilization from fires, to reduce spread of seeds of invasive species. This item will require additional analysis at the agency level.	BLM, FS	Initiate during 2007 fire season or before.
Require the use of knowledgeable resource advisors for fires within or threatening sage-grouse habitats. This item will require additional analysis at the agency level.	BLM, FS	Initiate during 2007 fire season or before.
Initiate the incorporation of overview training in sage-grouse habitat and related conservation issues, and suppression priorities during annual agency (including RFDs) firefighter training throughout southern Idaho (including Salmon/Challis). This item will require additional analysis at the agency level.	BLM, FS	Initiate during 2007 fire season training, annually thereafter.
Via instruction memorandum or other appropriate process, clarify the use of burn-out tactics in sage-grouse habitat. This item will require additional analysis at the agency level.	BLM, FS	Provide direction prior to the 2007 fire season or before.
Identify access roads where the installation of additional fire danger signs may be warranted. Install new signs as needed.	BLM, FS in cooperation with LWGs	Ongoing, but desirable to establish new signs in priority areas during the 2006 fire season, if warranted.

6.2.2 Annual grasslands

Category/Task	Responsible Party	Target Deadline
Require the washing of the undercarriage of fire vehicles and equipment prior to deployment and prior to demobilization from fires, to reduce spread of seeds of invasive species. This item will require additional analysis at the agency level.	BLM, FS	Initiate during 2007 fire season or before.
Explore means to require casual users of public/IDL lands to utilize certified weed-free forage. This item will require additional analysis at the agency level.	BLM, IDL	October 1, 2006

6.2.3 Sport hunting

Category/Task	Responsible Party	Target Deadline
Analyze existing wing data to determine the differences in sex and age of the harvest during opening weekend, compared to later in the season, and summarize other long-term trends.	IDFG	December 31, 2006
Identify sage-grouse populations where overharvest is a risk because of isolated or fragmented habitat or small numbers of birds. Develop appropriate 2006 hunting season recommendations to reduce risk.	IDFG	December 31, 2006

6.3 Monitoring related milestones

6.3.1 Population Monitoring

Category/Task	Responsible Party	Target Deadline
Identify lek monitoring goals (and primary and secondary lek routes) for SGPAs.	IDFG Regions	December 31, 2006
Explore the potential for initiating the "Adopt a Lek" program for Idaho, to increase monitoring of leks.	IDFG	December 31, 2006
Agency partners, volunteers submit completed lek monitoring forms to the appropriate IDFG Wildlife Manager or data steward for inclusion into the	BLM, FS, volunteers conducting lek surveys	No later than June 1 annually

Category/Task	Responsible Party	Target Deadline
statewide lek database.		

6.3.2 Habitat Monitoring

Category/Task	Responsible Party	Target Deadline
Establish SAC Technical Assistance Team (TAT), to aid in habitat, population, and data management/ analysis tasks.	IDFG HQ, SAC	August 31, 2006
SAC TAT and IDFG coordinate with agency contacts and LWGs during the fall/early winter each year to acquire spatial and related data needed for the annual update of the Sage-grouse Habitat Planning Map.	SAC TAT, IDFG	Acquire data from agency field-level offices and other partners by February 1 annually
Complete annual update of the Sage-grouse Habitat Planning Map including acreage summary (of key perennial grasslands, annual grasslands, conifer encroachment, by SGPA). Post on the FGDC Geospatial One Stop Clearinghouse node (Univ. Idaho), Sagemap, and DOI Geography Network.	IDFG HQ GIS	By March 1, annually
Review adequacy of the 2005 USGS Shrubmap to use as a tool to refine or replace the Sage-grouse Habitat Planning Map.	SAC TAT	December 31, 2007
Acquire updated infrastructure spatial data (e.g., new major paved roads, major power lines, communication towers, wind energy towers and related, oil/gas pipelines, geothermal sites etc.). Ensure updated infrastructure GIS product is made available to cooperators via web sites noted above.	SAC TAT, IDFG-HQ GIS	As needed
Delineate all known sage-grouse breeding and winter habitat at 1:100,000 (or 1:24,000 if possible), using best available information.	IDFG Regions in cooperation with land management agency biologists and LWGs	December 31, 2007
Evaluate the feasibility and appropriateness of establishing long-term habitat monitoring plots in specific areas such as: areas of priority to LWGs; habitats associated with priority lek routes; priority SGPAs; unique areas of local or regional importance.	IDFG research biologists, in cooperation with LWGs and SAC TAT	December 31, 2006

Category/Task	Responsible Party	Target Deadline
Establish a standardized template for LWG annual reports.	SAC TAT	October 31, 2006
Establish a database or spreadsheet for summarizing and reporting habitat accomplishments and related information from LWG annual reports and other agency/private projects.	SAC TAT	December 31, 2006

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FRAMEWORK FOR MITIGATION OF IMPACTS FROM INFRASTRUCTURE PROJECTS ON SAGE-GROUSE AND THEIR HABITATS

Sage-Grouse Mitigation Subcommittee of the
Idaho Sage-Grouse State Advisory Committee

December 6, 2010

INTRODUCTION

The Conservation Plan for Greater Sage-grouse in Idaho (Idaho Sage-Grouse Advisory Committee 2006) calls for the development of a "proposal for a mitigation and crediting program for sagebrush steppe habitats in Idaho and recommendations for policy consideration" (Measure 6.2.4.). In early 2010, the Idaho Sage-grouse Advisory Committee (SAC) established the Mitigation Subcommittee to complete this task.[1] The Mitigation Subcommittee met several times from the late spring, through the fall of 2010 and found broad areas of agreement among its diverse participants.

This report presents the Mitigation Subcommittee's consensus recommendations for the creation of an Idaho-based program to compensate for the impacts of infrastructure projects on sage-grouse and their habitats. This program – called the Mitigation Framework – would serve as a science-based "mitigation module" that project developers and government regulators could use to achieve compensatory mitigation objectives called for in project plans and permits. While compensatory mitigation may help offset certain impacts arising from infrastructure projects, mitigation should not be considered a substitute for first avoiding and then minimizing impacts. In addition, it is important to recognize that federal and state regulatory or land-management agencies, and county or local governments may also require additional stipulations, conditions of approval or other requirements as well as on-site mitigation, in accordance with applicable law, regulation or policy.

This document proposes a general outline or "skeleton" of policies and procedures for such a program. The Mitigation Framework is designed to be transparent, inclusive, and accountable to defined objectives. The Subcommittee's purpose is to describe the program in enough detail to foster a dialogue among SAC members, spot important issues and points of agreement, and assess the level of support for developing a functioning mitigation program for Idaho sage-grouse and their habitats.

[1] Subcommittee participants: John Robison and Lara Rozzell, Idaho Conservation League; Brett Dumas, Idaho Power Company; Paul Makela and Tom Rinkes, BLM; Don Kemner, Idaho Department of Fish and Game; Will Whelan and Trish Klahr, The Nature Conservancy; Rich Rayhill, Ridgeline Energy, LLC; Lisa LaBolle and Kirsten Sikes, Idaho Office of Energy Resources; Nate Fisher, Idaho Office of Species Conservation; John Romero, Citizen at Large.

EXECUTIVE SUMMARY

The state of Idaho is seeing an increasing number of infrastructure projects, such as transmission lines and wind energy facilities, proposed in the state's sagebrush steppe ecosystems. Where federal permits are required, the environmental review process for these projects will analyze how these projects affect sage-grouse and will consider a range of potential mitigation measures to avoid, minimize, or offset any impacts. It is likely that the environmental review process will lead at least some developers and agencies to implement compensatory mitigation.

Compensatory mitigation consists of compensating for residual project impacts that are not avoided or minimized by providing substitute resources or habitats, often at a different location than the project area. For sage-grouse, this would include, among other things, protecting and restoring sagebrush habitats to offset habitat losses and other effects of infrastructure projects.

This framework describes the general outline for a sage-grouse compensatory mitigation program in Idaho. This program would employ an "in-lieu fee" approach to compensatory mitigation through which a project developer would pay funds into an account managed by the mitigation program for performance of mitigation actions that provide measureable benefits for sage-grouse and their habitats within Idaho.

The Mitigation Framework does not alter the legal standards or procedures for review and approval of infrastructure projects. Rather, it offers an option that project developers and/or regulators may choose for implementing mitigation plans and agency permit conditions. It should be emphasized that this program would not relieve project developers and permitting agencies of their obligation to avoid and minimize environmental impacts through appropriate project siting, design and implementation.

Although the initial focus is on sage-grouse, the Mitigation Framework can be readily adapted to provide compensatory mitigation for other sagebrush obligate and associated species. The suitability of the Framework for other species and natural features has not been evaluated.

The objectives of the Mitigation Framework include:

- Provide a credible, efficient, transparent, and flexible mechanism to implement compensatory mitigation;
- Ensure that sage-grouse impacts are offset by actions that benefit the affected species and habitats;
- Provide increased certainty for developers and agencies;
- Involve private and public partners in crafting solutions;
- Provide developers the opportunity to offset the impacts of project development and operation on sage-grouse and sage-grouse habitat, and provide a consistent mechanism to offset impacts to the species that can be evaluated in future reviews of the species' status; and

- Evaluate issues based on best available scientific information, while acknowledging and responding to scientific uncertainty.

The Mitigation Framework would be established through a memorandum of agreement (MOA) among entities that have the capacity and commitment to assist in its implementation. Such parties may include land and wildlife management agencies, counties, tribes, participating private infrastructure development companies, and non-governmental organizations. The MOA would define the specific roles and responsibilities, procedures, and tasks needed to operate an Idaho-based compensatory mitigation program.

The Mitigation Framework envisions a program with the following attributes: (1) a Mitigation Team and program administrator to steer the mitigation program and ensure strong oversight; (2) technically sound guidelines for estimating compensatory mitigation costs; (3) a science-based statewide strategy to guide the selection of mitigation actions that will receive funding; (4) provisions that the costs of operating the program will be borne by infrastructure developers that use the Mitigation Framework to deliver compensatory mitigation; (5) monitoring the implementation and effectiveness of mitigation actions funded by the Mitigation Framework program; (6) a system to track benefits provided by the Mitigation Framework to sage-grouse habitat in Idaho; and (7) periodic evaluation and adaptation of the Mitigation Framework program.

This framework provides only a general outline of a proposed Idaho-based compensatory mitigation program. It is intended to assess the level of support for crafting the agreements and completing the technical tasks needed to bring the Mitigation Framework into being.

DISCUSSION

I. The Role of Compensatory Mitigation in Infrastructure Development and Sage-grouse Conservation

A. Mitigation Basics

Broadly defined, "mitigation" refers to a wide range of measures that are taken to avoid, minimize, rectify, reduce, or compensate for the adverse impacts of actions affecting the environment. *See* 40 C.F.R. § 1508.20 (definition of "mitigation" in National Environmental Policy Act (NEPA) rules). In this general sense, mitigation should be an integral part of all phases of project planning and implementation.

The focus of this report is on compensatory mitigation – also known as "biodiversity offsets" or "offsite mitigation." Compensatory mitigation consists of compensating for residual project impacts that are not avoided or minimized by providing substitute resources or habitats, often at a different location than the project area. For instance, a project developer may fund the restoration of a particular type of habitat in order to replace or "offset" similar habitat that is lost as a result of project construction.

This Framework adopts an "in-lieu fee" approach to compensatory mitigation. Under this approach, a project developer provides funding to a compensatory mitigation program administrator who then distributes the funds to the appropriate government agency, foundation or other organization for performance of mitigation actions. In an in-lieu fee program, the responsibility for actually delivering the compensatory mitigation is transferred from the developer to the program administrator once the developer provides the necessary funds to the in-lieu fee program.

It is important to emphasize that compensatory mitigation does not relieve project developers and permitting agencies of their obligation to avoid and minimize environmental impacts. This Framework endorses the principle known as the "mitigation hierarchy," which holds that decision makers should consider the elements of environmental mitigation in the following order of priority:

1. Avoid environmental impacts through project siting and design;

2. Minimize the impacts during construction, operation. maintenance, and decommissioning by implementing appropriate conservation measures related to timing and conduct of project activities;

3. Restore areas that have been disturbed or otherwise rectify on-site project-related impacts to the greatest extent practicable; and

4. Compensate for residual impacts (direct and indirect effects that are not mitigated on-site) by providing replacement habitats or other benefits.

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This means that compensatory mitigation is addressed only after efforts to avoid, minimize, and mitigate the impacts have been addressed. It also should be noted that significant impacts to habitat areas that support special functions and values for sage-grouse may simply not be replaceable through mitigation and therefore the best course may be to avoid those areas altogether.

B. Need for an Idaho Compensatory Mitigation Program

In recent years, the state of Idaho has seen an increase in the number of major infrastructure projects proposed in the state's sagebrush steppe ecosystems. Several current proposals involve high voltage transmission lines that would cross over hundreds of miles of sage-grouse habitat. Large scale energy infrastructure projects such as wind farms may also affect large areas of sage-grouse habitat.

Where these projects are located at least partially on federally managed public lands they will be required by federal law to go through an extensive environmental review process under NEPA before relevant federal permits are issued. The NEPA process requires the permitting agencies to consider the projects' environmental effects (both positive and negative), alternatives, and potential mitigation measures. Impacts on sage-grouse will be one of the topics analyzed in the NEPA process.

Even after efforts are taken to avoid and minimize impacts, it is possible that some of these infrastructure projects will degrade some sage-grouse habitat, cause direct sage-grouse mortality, or lead to indirect effects such as avoidance of previously occupied habitat. The extent to which project developers and regulators adopt compensatory mitigation as a means to offset these impacts is not fully known. However, it is likely that at least some developers and regulators will seek to implement compensatory mitigation to benefit sage-grouse and their habitats.

Energy companies and other developers face daunting challenges in carrying out compensatory mitigation for sage-grouse habitat. Just identifying specific mitigation actions requires a major effort. Actually implementing sagebrush restoration and enhancement projects is even more difficult and expensive – typically involving years of effort and a significant risk of failure. Delivering this type of technically complex environmental mitigation may be well outside the core business of many infrastructure developers.

C. Advantages of the Mitigation Framework

The Mitigation Framework proposes to respond to these challenges by creating a statewide program to deliver scientifically sound compensatory mitigation for multiple projects. Project developers and regulators would no longer have to design, fund and implement their own mitigation programs. Instead, they would have the option of contributing money to a central fund overseen by agencies with expertise in habitat management and non-governmental partners with similar experience.

This approach to compensatory mitigation offers three major advantages. The first advantage stems from the increased efficiency of an Idaho-wide mitigation program compared with fragmented, project-by-project mitigation programs. Mitigation efforts require a significant investment in planning, administration, project oversight, and monitoring. The Mitigation Framework would consolidate these functions, thus avoiding needless duplication.

The second advantage is that a state mitigation fund can be used for sage-grouse conservation more strategically and at a greater scale than project-by-project mitigation. As described in more detail below, the Mitigation Framework would fund sage-grouse habitat protection and restoration projects in accordance with a statewide strategy that uses landscape-scale analyses to identify the specific measures and habitats that will provide the greatest benefit for Idaho sage-grouse populations. This Idaho-based mitigation strategy will be integrated with other conservation strategies throughout the range of sage-grouse to ensure that actions taken in Idaho benefit the species as a whole.

Third, this method can engage the capacity and competence of natural resources agencies, local governments, private companies, and non-governmental organizations. The Mitigation Framework proposes to enlist these entities in shaping Idaho's strategy, developing criteria for use of the fund, and proposing and implementing habitat protection and restoration projects.

The benefits of the Mitigation Framework can be summarized as follows:

Benefits for Project Developers:

An efficient and reliable mechanism for meeting compensatory mitigation objectives and permit conditions; and

Increased certainty regarding project costs.

Benefits for Regulatory Agencies:

Increased certainty that in-lieu fees will result in strategic "on-the-ground" mitigation actions that benefit sage-grouse.

Benefits for Sage-Grouse:

Increased certainty that scientifically sound mitigation actions that benefit sage-grouse and offset impacts and habitat losses associated with infrastructure development will be implemented.

D. Ensuring Accountability

In-lieu fee compensatory mitigation does pose one potentially significant drawback that must be acknowledged and addressed: a poorly designed program may lack accountability for delivering meaningful on-the-ground benefits for sage-grouse. Simply having a project developer contribute to an in-lieu fee mitigation account does not by itself compensate for the sage-grouse impacts caused by the project. Actual mitigation is possible only after well-conceived habitat protection and restoration projects are planned, funded, implemented, monitored, and successful in achieving stated objectives.

The Mitigation Framework seeks to ensure accountability by adopting a series of rigorous and transparent procedures. As described below, the Framework would: (1) ensure that program administration and monitoring functions are adequately funded; (2) provide technically sound guidelines for estimating the costs of delivering compensatory mitigation; (3) establish a science-based statewide strategy to guide the program; (4) develop project selection criteria and a request for proposals based on the strategy; (5) require monitoring of the implementation and effectiveness of mitigation actions funded by the program; (6) track benefits the Mitigation Framework program provides to sage-grouse in Idaho; and (7) require periodic evaluation of the program. Taken together, these procedures provide a high degree of certainty that the Mitigation Framework will be able to turn in-lieu fee payments into tangible, lasting compensatory mitigation for sage-grouse.

As described in greater detail in Section E, below, project developers that seek to use the Mitigation Framework will need to show two things. First, they will need to show that their projects' impacts on sage-grouse and their habitats have been evaluated using a scientifically sound process. Second, they will need to show that their contributions to the mitigation fund reflect the Mitigation Framework's compensation guidelines to ensure that funding will be adequate to offset project impacts. Having demonstrated those things, the project developers should then be able to rely on their in-lieu fee contribution to the mitigation account as satisfying their compensatory mitigation objectives or obligations.

II. Core Elements of Idaho Sage-Grouse Mitigation Program

A. Program Objectives

- Provide a credible, efficient, transparent, and flexible mechanism to implement compensatory mitigation;
- Ensure that sage-grouse impacts are offset by mitigation actions that benefit the sage-grouse and their habitats;
- Provide increased certainty for developers and agencies;
- Involve private and public partners in crafting solutions;
- Provide developers the opportunity to offset project impacts on sage-grouse and sage-grouse habitat, and provide a consistent mitigation mechanism that can be evaluated in future reviews of the species' status; and
- Evaluate issues based on best available scientific information while acknowledging and responding to scientific uncertainty.

B. Scope

The Mitigation Framework proposes to mitigate for impacts to Idaho sage-grouse and their habitats in Idaho.

The initial focus of the Mitigation Framework is on sage-grouse. However, this program can be readily adapted to provide compensatory mitigation for other sagebrush obligate and associate species, such as pygmy rabbits, if project developers and regulators call for such mitigation. Whether this Framework is suited for mitigation of impacts to a broader suite of species or natural features has not been evaluated. It should be noted that some subcommittee members expect to advocate in other forums that compensatory mitigation should extend beyond sage-grouse.

The Mitigation Framework focuses on infrastructure projects because this type of development is the most likely to give rise to compensatory mitigation under existing environmental policies. As used here, the term "infrastructure" refers to building structures that significantly disturb sage-grouse habitat, including but not limited to projects for electricity transmission, energy generation, pipeline conveyance, transportation, communications, and similar purposes.

The Mitigation Framework is not intended to apply to existing projects that are not changing in scope or to the renewal of on-going activities, such as grazing permits. In addition, the Framework is not suited to projects with minor impacts because their contributions to the mitigation program would be too small to justify the effort needed to establish and administer in-lieu fee payments.

C. Integration with Environmental Review Procedures

The Mitigation Framework does not alter the legal standards or procedures for review and approval of infrastructure projects. Rather, the Framework offers an option that project developers and/or regulators may choose for implementing mitigation plans and agency permit conditions.

The Mitigation Framework is intended to complement the environmental review process conducted pursuant to NEPA and other federal environmental laws as well as county land use planning authorities.

Many energy and other infrastructure projects undergo review and approval at the county level. The issues examined and the level of environmental analysis varies widely among individual counties and individual developers. If a county or developer decides to address sage-grouse impacts, it will be able to use the Mitigation Framework as a mechanism for meeting compensatory mitigation objectives that may arise from the county permitting process.

D. Mitigation Strategy

The next step focuses on the Mitigation Team's task of developing a statewide, science-based strategy that will guide the use of the mitigation fund.

The mitigation program strategy would establish priorities for the use of compensatory mitigation funding based on factors/risks identified in the U.S. Fish and Wildlife Service's 12-Month Findings for Petitions to List Greater Sage-Grouse (*Centrocercus urophasianus*) as Threatened or Endangered (USFWS 2010) and in the Conservation Plan for Greater Sage-grouse in Idaho (2006). The strategy sets mitigation priorities with a landscape view of sage-grouse needs and highlights mitigation opportunities in Idaho based on best available science. In setting priorities, the strategy considers species and community size, landscape condition, and regional context. The strategy is responsive to the threats and risks described in the sage-grouse 12-month findings. The strategy will also generally describe the types of mitigation actions, project specifications, and best practices that are likely to produce measureable benefits for sage-grouse habitat. Finally, the strategy addresses both implementation and effectiveness monitoring requirements for mitigation actions funded through the program.

The Mitigation Framework's strategy will draw heavily from the State of Idaho's sage-grouse conservation plan but has a narrower focus. It is intended to provide the specific guidance on program priorities, accepted mitigation measures, and geographic areas of emphasis that potential mitigation project sponsors will need to know when they apply for funds. The strategy plays a crucial role in steering mitigation funding to those activities and places that can provide the most effective benefits for Idaho sage-grouse populations consistent with strategies to increase the viability of the species throughout its range.

To this end, the strategy will address one of the major policy questions that arise in the design of compensatory mitigation systems: how closely should the mitigation actions be linked to the type and location of the habitat that was originally affected by the infrastructure project. Stated in the alternative, does removal of the mitigation action from the area of impact improve the effectiveness of or benefit from the action. Some compensatory mitigation systems place a heavy emphasis on this link by favoring "in-kind" and "on-site" compensatory mitigation over

"out-of-kind" and "off-site" compensatory mitigation. The subcommittee members generally favor an approach that allows funding to flow to the projects and locations within Idaho that will provide the greatest overall positive impact on sage-grouse populations. The Mitigation Framework calls for a monitoring program that would assess habitat gains provided by mitigation actions and compare them with the mitigation objectives of the participating infrastructure projects. The nature and purpose of this monitoring is described more fully in Mitigation Program Step 4, below.

Once the strategy is complete, the Mitigation Team will develop project ranking criteria and procedures that will guide the selection of the mitigation actions that will receive funding. The goal is to fund projects that provide high quality, lasting benefits based on landscape scale analyses that actually compensate for project impacts.

E. Compensation Guidelines

The Mitigation Framework Program will develop guidelines that may be used by developers and/or regulators to determine the cost of meeting their compensatory mitigation objectives. These compensatory mitigation objectives determine the extent of compensatory mitigation for each project and are generally incorporated into project plans or permits.

The compensation guidelines will provide transparent, technically sound principles for determining how much it costs to deliver habitat mitigation for sage-grouse. In other words, the guidelines will represent best estimates of the true cost of implementing the mitigation actions needed to meet each project's compensatory mitigation objectives. The guidelines may be used by the project developer and the Mitigation Framework Program Administrator to establish the in-lieu fee that the developer will contribute to the mitigation fund.

Specific valuation methods will be developed at a later time and will likely draw from compensatory mitigation systems used elsewhere in the West. Although the details have yet to be worked out, the following outline illustrates the core concepts and principles (shown in bold lettering) that are likely to be employed by the MOA parties in setting the Mitigation Framework's in-lieu fee structure.

- A **common unit of measurement** would be established for describing and tracking both the project impacts and the benefits of any compensatory mitigation actions. This unit of measurement can be a physical unit such as "acres impacted" or more specifically "acres of summer brood rearing habitat impacted" or "habitat units" lost.

- While the "common unit of measurement" noted above addresses the area of habitat impacted and mitigated, **habitat compensation ratios** are used to address the **quality** of the habitat affected by the infrastructure project. These ratios could specify the number of acres of mitigation required per acre of impacted habitat based on the size, habitat quality/condition and function of the impacted habitat; for more critical or important habitat, more mitigation acres might be required. Thus, habitats with higher quality and importance could have higher compensation ratios.

- Several factors are taken into account in calculating how much it will cost to actually compensate for the acres or habitat units. The recommended approach is to evaluate on

the costs of implementing a conceptual **portfolio of potential mitigation actions** or offset activities that provide benefits for sage-grouse. This portfolio of model projects would include a balanced mix of accepted habitat protection and restoration measures reflecting the types of projects expected to be funded by the mitigation program (in accordance with the strategy discussed above). Examples of projects in this portfolio may include such actions as restoring sagebrush canopy and a native understory on recently burned land, improving riparian areas and wet meadows in early brood-rearing habitat, conservation easements to prevent habitat loss, and land management practices that improve sage-grouse habitat. Project costs include the full range of expenses needed to complete all phases of the mitigation action, including administration and monitoring. The average costs of these model mitigation actions per acre or habitat unit is the foundation of the in-lieu fee calculation.

- In addition, the in-lieu fee should also be adjusted to take into consideration the issue of **lag time** –the time between when habitat is lost at the impacted site relative to when habitat functions are gained at the compensation site.

- The fee also needs to account for **contingencies** associated with delivering compensatory mitigation, including an estimate of the **risk of failure** (i.e., the probability that offsite mitigation will not result in any measureable conservation outcomes) for each mitigation site or project.

- In addition to the fee calculated above, costs for establishing and operating the program, including travel, technical consultation and monitoring of program effectiveness must be included. This overhead fee could range from 5-15% depending on the size and complexity of the proposed mitigation program.

F. Program Structure and Oversight

The Mitigation Framework would be established through a memorandum of agreement (MOA) among the entities that would participate in its implementation. The MOA would define the specific roles and responsibilities, procedures, and tasks needed to operate an Idaho-based compensatory mitigation program. The MOA would serve as a joint powers agreement for state and local government parties.

The MOA would establish the following administrative structure for the Mitigation Framework:

1. **Core Team:** A core group would oversee the Mitigation Framework program and provide policy-level guidance for the Science Team and Fund Administrator, described below. The Core Team would be composed of three to seven representatives of diverse perspectives among the MOA signatories.

2. **Science Team:** A team of experts drawn from MOA signatories and other targeted organizations will administer the science-based and technical aspects of the program. The Science Team would consist of several individuals with expertise in relevant areas such as habitat protection and restoration, landscape ecology/spatial analysis, wildlife biology, sage-grouse ecology, project development, and mitigation policy.

The Team would focus on developing the policies and statewide strategy that will guide the program, making requests for mitigation project proposals (RFPs), ranking mitigation proposals that will receive funding, tracking monitoring reports and project benefits, and evaluating program success.

3. **Program Administrator:** A program administrator will be responsible for fund management and administrative tasks. The program administrator will provide administrative support for the Mitigation Team, manage the mitigation account, and administer grants, contracts, and other agreements.

4. **Advisory Committee:** A broader advisory committee consisting of agencies, companies and organizations with the skills and commitment that will provide useful advice to the Core Team regarding the implementation of the Mitigation Framework.

The specific make up of each of these groups will be determined at a later time. Potential participants in the Mitigation Framework include but are not limited to representatives of:

State of Idaho:
- Department of Fish and Game
- Office of Energy Resources
- Office of Species Conservation
- Idaho Department of Lands

Energy Companies:
- Idaho Power
- Ridgeline Energy

Idaho Tribes
Idaho Sage-Grouse Advisory Committee
Sage-Grouse Local Working Groups

United States:
- Bureau of Land Management
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- Natural Resources Cons. Service

Non-Governmental Organizations:
- Idaho Conservation League
- The Nature Conservancy

Idaho Counties
Public Land Users (e.g., grazing interests)

G. Funding the Mitigation Program

The costs of administering the program will be sustained by the project developers that seek compensatory mitigation. Therefore, a portion of the in-lieu fee that project developers contribute to the mitigation account will be applied for program administration. As noted above, protecting and restoring sagebrush habitats are time consuming and expensive undertakings. Ensuring that these activities are conducted with strong oversight should be viewed as an exceptionally wise investment.

III. Mitigation Program Steps

The Mitigation Framework envisions a five-step process for developing, implementing, and monitoring compensatory mitigation.

A. Step 1 – Assessment of Project Impacts and Development of Mitigation Objectives

Assessment of project impacts should be undertaken by the project developers proposing new infrastructure projects and the government agencies that conduct environmental reviews of those projects. Although the Mitigation Framework process is not responsible for this step, it is nevertheless crucial to the integrity of the mitigation program. Specifically, the Framework's success in achieving its goal of offsetting major infrastructure project impacts on sage-grouse depends on an accurate accounting of those impacts.

For many projects, this analysis will be done as part of the environmental review procedures required by NEPA. As noted above, NEPA requires federal agencies to address the full range of direct, indirect and cumulative impacts of the proposed project, alternatives to the proposed action, and potential mitigation before they act on permit applications.

Once impacts have been assessed and compensatory mitigation objectives set, the project developer is ready to engage the Mitigation Framework, starting with determining the developer's in-lieu fee contribution.

B. Step 2 – Determine the In-lieu Fee Contribution

The goal of Step 2 is to use valuation techniques, such as the guidelines presented above, to convert the complex range of project impacts, including direct, indirect and cumulative impacts, into monetary terms that become the basis for the in-lieu fee payment. The accepted in-lieu fee compensatory mitigation plan could be a condition of the instrument approving the project (FONSI, ROD, right-of-way grant, conditional use permit, etc.) and thus legally requires the project developer comply with the approved mitigation plan.

C. Step 3 – Commitment of Mitigation Funds by Project Developer

Infrastructure project developers can employ the Mitigation Framework by entering into an agreement with the program administrator with regard to a specific infrastructure project. This project agreement sets forth the parties' respective responsibilities, including the project developer's commitment to pay the in-lieu fee. Importantly, the agreement provides that the project developer's funds can only be used for the purposes set forth in the Mitigation Framework. The agreement may also include "conditions" as requested by regulatory agencies or project developers. For instance, the agreement might provide that the in lieu fee will be used to fund mitigation actions in specific geographic areas in order to meet permit requirements. The program administrator, based on consultation with the MOA parties, may decline to enter into an agreement that is inconsistent with the Mitigation Framework principles or includes conditions that are burdensome or unworkable.

Once the agreement specifying the payment structure and schedule is signed, the project developer makes the required in-lieu fee deposits to an interest bearing account managed by the program administrator.

After the completion of this step, the project developer is no longer engaged in the Mitigation Framework – unless it has decided to participate as a MOA party.

D. Step 4 – Issue Request for Proposals (RFP) and Select, Implement, and Monitor Mitigation Actions

At least at annual intervals, the Mitigation Team will issue an RFP that invite private companies, non-governmental organizations, and agencies to submit proposals for sage-grouse habitat protection, restoration, and/or enhancement actions. The RFP will provide guidance to mitigation project sponsors on program priorities and criteria. These priorities and criteria will be drawn from the mitigation program strategy including identification of geographic areas where mitigation might provide the greatest benefits as well as identification of the threats that present the highest risk to the species or its core habitat. The Mitigation Team should also reach out to federal, state, and local agencies, non-governmental organizations and the general public in order to facilitate discussion, engage stakeholders, raise awareness of the program and generate responses to the RFP.

The RFP will solicit project proposals that contain an operation or implementation plan and address at least the following elements:

- Geographic area;
- Threats addressed and how the mitigation action project will offset impacts resulting from those threats;
- An analysis of current sage-grouse conditions in the area;
- Resource goals and objectives the mitigation action project will seek to provide;
- A description of any coordination with federal, state, tribal and local resource management and regulatory authorities or other stakeholder involvement required to complete the mitigation action (e.g., requirement for NEPA compliance or county permit);
- A description of recent or proposed projects and events in the vicinity of the proposed project, if any, such as fire rehabilitation treatments, restoration or enhancement treatments or other activities that complement the effectiveness or intent of the proposed, mitigation action;
- A description of the long term protection, management, stewardship for the project being implemented, and the entity responsible for these activities; and
- A commitment to periodic evaluation and reporting on the progress of the project in meeting stated goals and objectives, including a process for adaptively redirecting the project if necessary.

When selecting projects, the Mitigation Team will estimate the biological benefits of the projects activities, the likely success of those activities, the duration of benefit expected and measure those benefits in relation to the strategy and RFP objectives.

Mitigation Team and the program administrator will work together on-going program administration and oversight including annual reporting of program activities, expenditures, and benefits. An annual program report will describe program activities, budget, and assessment of whether the mitigation strategy and associated projects are benefitting sage-grouse and at what level or scale.

The Mitigation Team and/or Program Administrator should implement a monitoring program to measure and validate whether project-specific objectives have been met. Monitoring is required of all compensatory mitigation actions to determine if the project is meeting its performance standards and objectives. As mentioned above, at regular intervals, the total habitat and/or population gains provided by the programs will be compared with the habitat/population losses associated with the participating infrastructure projects. The purpose of this comparison is to evaluate the mitigation program and make any necessary program adjustments – particularly if the monitoring shows that the mitigation benefits are not compensating for habitat losses. This comparison will not be a basis for imposing new, unexpected requirements on the infrastructure project developers.

CONCLUSION

The framework of policies, principles and procedures outlined above are meant to start a dialogue among parties engaged in sage-grouse conservation and infrastructure development. If these parties agree with the Mitigation Subcommittee that there is great value in establishing an Idaho-based compensatory mitigation program, then this framework will mark the beginning of an inclusive effort to fill in the details and complete the tasks needed to bring such a program into being. We have confidence in our collective ability to create a compensatory mitigation program that will benefit infrastructure developers, agencies, conservation interests, and – not least – Idaho's sage-grouse.

3-201
(1/97)

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

FEDERAL FISH AND WILDLIFE PERMIT

2. AUTHORITY-STATUTES
16 USC 1539(a)(1)(A)

REGULATIONS (Attached)
50 CFR §§ 13 & 17

3. NUMBER
TE200957-1

1. PERMITTEE

Center of Excellence for Hazardous Materials Management
505 North Main Street
Carlsbad, New Mexico 88220
Phone: 575/885-3700
e-mail: dclynn@cehmm.org

4. RENEWABLE	5. MAY COPY
[X] YES	[X] YES
[ ] NO	[ ] NO
6. EFFECTIVE 12/08/2008	7.EXPIRES 12/08/2028

8. NAME AND TITLE OF PRINCIPAL OFFICER (if #1 is a business)
Douglas C. Lynn, Executive Director

9. TYPE OF PERMIT
Endangered Species – Incidental Take

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED
The planning area includes all lands currently occupied or potentially occupied by the LPC or SDL, includes approximately 2,200 mi^2 in the southeastern section of New Mexico within portions of Lea, Eddy, DeBaca, Curry, Roosevelt, Quay, and Chaves counties, New Mexico.

11. CONDITIONS AND AUTHORIZATIONS:

A. GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2, ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORDANCE WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED. CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B. THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL OR OTHER FEDERAL LAW. THIS PERMIT DOES NOT WAIVE THE OBLIGATION TO ABIDE BY OTHER FOREIGN, STATE, LOCAL OR FEDERAL LAW IN CARRYING OUT AUTHORIZED ACTIVITIES.

C. VALID FOR USE BY PERMITTEES NAMED ABOVE.

D. ACCEPTANCE OF THIS PERMIT SERVES AS EVIDENCE THAT THE PERMITTEE UNDERSTANDS AND AGREES TO ABIDE BY THE "GENERAL C ONDITIONS FOR NATIVE ENDANGERED AND THREATENED WILDLIFE SPECIES PERMITS" **(copy enclosed).**

12. REPORTING REQUIREMENTS
Annual reports due January 1 of each year the permit is in effect.

ISSUED BY:	TITLE	DATE
Bd Milks	Deputy Regional Director	12/8/08

E. The Center of Excellence for Hazardous Materials Management (CEHMM) will be responsible for implementing and administering the Candidate Conservation Agreement with Assurances (CCAA). CEHMM will enroll property owners under the CCAA through the issuance of Certificates of Inclusion (CI) for the lesser prairie-chicken (*Tympanuchus pallidicinctus*) (LPC) and sand dune lizard (*Sceloporus arenicolus*) (SDL). Participating Landowners will actively implement conservation measures for the species, as described in the CCAA. CEHMM will process and monitor all CIs to document that the conservation measures implemented on the enrolled properties will provide a conservation benefit to the LPC and SDL. The planning area includes all lands currently occupied or potentially occupied by the LPC or SDL, and includes approximately 2,200 mi^2 in the southeastern section of New Mexico within portions of Lea, Eddy, De Baca, Curry, Roosevelt, Quay, and Chaves counties, New Mexico. The initial focus of the CCAA will be in Lea, Eddy, and Roosevelt counties, New Mexico.

F. Subject to CEHMM's compliance with all other terms and conditions of this Permit, and the Agreement, this Permit will take effect for the LPC and SDL, candidate species, upon the listing of such species as threatened or endangered by U.S. Fish and Wildlife Service (FWS).

G. CEHMM, along with representatives from the FWS, will meet with participating landowners at their request to provide technical assistance, including discussions of funding options, for conservation measures to be applied to their enrolled property.

H. CEHMM will annually lead a meeting with the FWS and all participating landowners enrolled under the CCAA to review progress from the previous year, discuss factors influencing LPC and SDL conservation and management, and discuss actions that could benefit LPC and SDL to be initiated in the upcoming year.

I. The CCAA will have a duration of 20 years from the date the CCAA is signed, and may be renewed before it expires. The CCAA will cover participating landowners from the date their land(s) are enrolled until the end of their participation in the CCAA, wither through expiration or termination. Should the LPC or SDL be listed as threatened or endangered, and all other requirements are met, the permit will be issued to CEHMM and all participating landowners will be covered from that date until the end of their participation in the CCAA, either through expiration or termination. The duration of participation is five years, but can be the full duration of the CCAA.

J. Terms and conditions of the permit shall be binding on, and for the benefit of, the Permittee and its successors and assigns, as well as holders of valid CIs. If the permit or associated documents require an amendment because of change of ownership, the FWS will process that amendment without the requirement of the Permittee preparing any new documents over and above that required in the original permit, providing the new owner agrees to the terms and conditions of the original permit. The construction activities proposed or in progress under an original permit may not be interrupted provided the required terms and conditions of an issued permit are being followed.

K. Written annual reports of the year's activities, including biological data collected and CIs issued in each year this permit is in effect must be submitted by January 15th to the U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, 2105 Osuna NE, Albuquerque, New Mexico 87113; and to the U.S. Fish and Wildlife Service, Regional Office, P.O. Box 1306, Room 6034, Albuquerque, New Mexico 87103.

L. Upon locating a dead, injured, or sick LPC or SDL, or any other endangered or threatened species, the Permittee is required to contact the FWS's Law Enforcement Office, Albuquerque, New Mexico (505) 346-7828 or El Paso, Texas (915) 872-4765, for care and disposition instructions. Extreme care should be taken in handling sick or injured individuals to ensure effective and proper treatment. Care should also be taken in handling dead specimens to preserve biological materials in the best possible state for analysis of cause of death. In conjunction with the care of sick or injured endangered/threatened species, or preservation of biological materials from a dead specimen, the Permittee and holders of valid CIs have the responsibility to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

M. If, during the tenure of this permit, the project design and/or the extent of the habitat impact described in the CCAA is altered, such that there may be an increase in the anticipated take of the LPC, the Permittee is required to contact the FWS and obtain authorization and/or amendment of the permit before commencing any activities that might result in incidental take beyond that described in the Environmental Assessment (EA) and/or Candidate Conservation Agreement with Assurances (CCAA).

N. The authorization granted by the permit is subject to full and complete compliance with, and implementation of, the EA and CCAA for the Permittee and the FWS; and all specific terms and conditions contained in this permit. These permit terms and conditions shall supersede and take precedence over any inconsistent provisions in the EA and CCAA, or other associated permit documents.

O. Acceptance of the permit serves as evidence that the Permittee understands and agrees to abide by the terms and conditions of the permit and all applicable Sections of Title 50 Code of Federal Regulations Parts 13 and 17 pertinent to issued permits.

P. Upon listing of either LPC and/or SDL, no additional enrollments under the CCAA may occur for the listed species. A summary of enrolled landowners, the number of acres enrolled, number of acreages designated as "conservation lands", and the activities, oil and gas development or ranching, and the intensity of these activities on the remainder of the enrolled properties as documented in their CIs.

Q. Incidental take is authorized for the LPC and SDL, at the time of a future listing as either threatened or endangered, at the level consistent with activities documented in the CIs for enrolled landowners under the CCAA at the time of a future listing. Incidental take of the LPC and/or SDL will be exceeded, if participating landowners are not implementing their conservation commitments or the land use has changed such that the level of effects on the

conservation lands is not consistent with the level of effects under the CCAA, as documented in the CIs.

------End of Permit Terms and Conditions for Permit # TE200957-1------

Wyoming Species of Greatest Conservation Need

Element 1 of the Congressional guidelines for State Wildlife Action Plans (SWAPs) specifies that each state must provide "information on the distribution and abundance of species of wildlife, including low and declining populations as the state wildlife agency deems appropriate, that are indicative of the diversity and health of the state's wildlife." These species have been termed Species of Greatest Conservation Needs or SGCN.

Identifying SGCN

Over 800 species of wildlife exist in Wyoming. This figure does not include plants and terrestrial invertebrates, which do not fall within the Wyoming Game and Fish Department's (WGFD) jurisdiction. SGCN designation is intended to identify species whose conservation status warrants increased management attention, and funding, as well as consideration in conservation, land use, and development planning in Wyoming. SGCN designation can be derived from known population or habitat threats or a lack of sufficient information to adequately assess a species' status.

The WGFD's SGCN designation process is based upon its Native Species Status (NSS) classification system. During the early 1980s, the WGFD conducted a series of analyses to identify species of special concern. A system was developed that used a matrix to evaluate a species' status in relation to population (y-axis) and habitat variables (x-axis). In the 2005 Comprehensive Wildlife Conservation Strategy (CWCS),[1] a 16-cell matrix was used for birds and mammals and a 9-cell matrix for fish, reptiles, amphibians, and invertebrates. An NSS rank was assigned for an individual species based on the intersection of the two most appropriate population and habitat conditions. For the purposes of the 2005 CWCS, species identified as NSS1, NSS2, NSS3, or NSS4 were considered to be SGCN.

Since that time, it was determined that using a separate matrix for fish, reptiles, amphibians, and invertebrates was too cumbersome, and a revised approach was created for the 2010 SWAP. The revised NSS matrix has 16 cells (Table 1). The y-axis consists of population variables, which range on a continuum from populations declining with extirpation possible (row A) to populations that are widespread and expanding (row D). After identifying the appropriate row for a species population, the most appropriate limiting factor column is selected from the x-axis, ranging from limiting factors that are severe and worsening (column a) to limiting factors that are moderate and not likely to increase (column d). Limiting factors include habitat, human activity levels, genetics, invasive species, disease, environmental contaminants, and climate change (Table 2). Additional limiting factors may be identified in the future. The matrix cell established by the intersection of the selected row and column identifies the NSS rank for a species. As a species moves from a placement closest to the upper left corner of the matrix (Aa/NSS1) toward the lower right corner (Dd/NSS7) the species' population status in Wyoming is considered more secure. Some combinations of population status and limiting factors are unlikely to occur and are not assigned an NSS rank. Notes on the SGCN designation are included with each species account.

This system cannot be used for classifying some species because necessary information is lacking. These species are placed in a separate status category as NSS Unknown (NSSU) until additional information is obtained. Species that receive an NSS rank of NSS1, NSS2, NSS3, NSS4, or NSSU were recommended to the Wyoming Game and Fish Commission to receive SGCN designation for the 2010 SWAP. NSSU species were recommended to receive the SGCN designation because obtaining a greater understanding regarding population numbers and distributions of these species is necessary in determining their conservation status, including responding to petitions for listing under the

[1] Comprehensive Wildlife Conservation Strategy was the previous name for Wyoming's State Wildlife Action Plan.

Endangered Species Act. Some species with naturally low numbers and limited distributions were not recommended to receive SGCN status if both the following qualifications were met:

1. The species in Wyoming is not experiencing known population declines or increasing threats, and
2. The species' population is abundant and secure throughout its range.

Only species that are legally considered wildlife in Wyoming were evaluated for SGCN status. Wyoming Statute 23-1-101 (a) (xiii) defines "wildlife" as all wild mammals, birds, fish, amphibians, reptiles, crustaceans and mollusks, and wild bison designated by the Wyoming Game and Fish Commission and the Wyoming Livestock Board within Wyoming. Plants and invertebrates (excluding crustaceans and mollusks) are outside the jurisdictional authority of the WGFD and were not considered for SGCN status. To increase understanding about Wyoming's invertebrates, a cooperative agreement was signed between the WGFD and the Wyoming Natural Diversity Database (WYNDD) in May 2010.

SGCN designation was applied at the most appropriate taxonomic level based on current management practices (see Appendix B for a description of taxonomic approach for mammals and birds). This was usually the species level. Examples of exceptions at the subspecies level included the Preble's jumping mouse, four subspecies of cutthroat trout,[2] and a number of reptiles and amphibians. Most mollusks and crustaceans were organized at the genus, family, or order level, based on shared morphology, habitats, threats, and limited information.[3] Basic life history information, population survey methods, and identification techniques for these mollusks and crustaceans is extremely limited. Consequently, addressing the conservation of these species at a lower taxonomic level is impractical until additional information is available.

[2] Bonneville, Yellowstone, Snake River, and Colorado River.
[3] Mollusk groups: aquatic snails, land snails, oreohelix mountain snails, pill clams, and stagnicola pondsnails. Crustacean groups: shrimp.

Table 1. 2010 SWAP Native Species Status Matrix

		Limiting Factors			
		a. EXTREME Limiting factors are severe and continue to increase in severity	**b. SEVERE** Limiting factors are severe and not increasing significantly	**c. MODERATE** Limiting factors are moderate and appear likely to increase in severity	**d. MINIMAL** Limiting factors are moderate and not likely to increase in severity
Population Status	**A. IMPERILED** Population size or distribution is restricted or declining and extirpation is possible	Aa **NSS1**	Ab **NSS2**	NOT APPLICABLE	NOT APPLICABLE
	B. VULNERABLE Population size or distribution is restricted or declining but extirpation is not imminent	Ba **NSS2**	**NSS3**	Bc **NSS4**	Bd NOT APPLICABLE
	C. STABLE Population size and distribution is stable and the species is widely distributed	***Ca*** NOT APPLICABLE	Cb **NSS4**	Cc NSS5	Cd NSS6
	D. EXPANDING Populations are expanding in number and/or distribution and the species is widely distributed	***a*** NOT APPLICABLE	***C***	Dc NSS6	Dd NSS7

Table 2. Description of SWAP NSS Matrix Limiting Factors

Limiting Factors	**a.** **EXTREME** Limiting factors are severe and continue to increase in severity	**b.** **SEVERE** Limiting factors are severe and not increasing significantly	**c.** **MODERATE** Limiting factors are moderate and appear likely to increase in severity	**d.** **MINIMAL** Limiting factors are moderate and not likely to increase in severity
Habitat	Deteriorating Significant ongoing and increasing loss of habitat or extremely limited habitat	Restricted Significant loss of habitat	Vulnerable Habitat is vulnerable but not currently restricted; increases in habitat loss likely	Stable Habitat is secure and/or widespread
Human activity	Highly sensitive Disturbance significantly and increasingly impacting populations	Sensitive Disturbance significantly impacting populations	Adaptive Disturbance currently results in moderate population reductions; additional losses likely	Tolerant Species routinely occupies disturbed environments and habitats closely associated with humans
Genetics	Deteriorating Species significantly declining in genetic purity or ongoing hybridizations	Restricted Unaltered genetic base is severely restricted geographically or genetically	Vulnerable Unaltered genetic base is currently stable but vulnerable to hybridization or loss of genetic diversity	Stable Desired genetic base is secure and widespread
Invasive species	Deteriorating Invasive species causing significant and increasing population impacts and loss of habitat	Restricted Invasive species causing significant population impacts or loss of habitat	Vulnerable Invasive species impacts moderate but expected to increase in severity	Stable No current or expected impacts from invasive species
Others Disease Contaminants Climate change				

Changes in SGCN from 2005

The re-evaluation of SGCN for the revised 2010 SWAP resulted in 180 species receiving SGCN designation (Table 3). This included 56 birds, 46 mammals, 30 fish, 8 amphibians, 21 reptiles, 5 crustaceans, and 14 mollusks.[4] Wyoming's 2005 CWCS included 279 SGCN.[5] Reasons for changes in SGCN status are listed in Appendix B.

SGCN Prioritization

Due to resource limitations, it is not possible to provide equal attention to all of Wyoming's SGCN and achieve quantifiable conservation results. SWAPs are required to be coordinated with federal, state, and local agencies. Increasingly, these entities are looking to the SWAP for guidance in directing wildlife conservation activities.

By itself, the WGFD's NSS ranking system has limitations in conveying conservation priority. First, the NSS system does not take into account the issue of peripheral ranges. A species could be common and secure throughout its range, but receive a high NSS rank solely because Wyoming is on the periphery of its range. The NSS ranking system does not differentiate these species from species that have a substantial portion of their range in Wyoming and are facing increasing threats, or from species that have limited ranges in the state, but for which Wyoming is likely to play a significant role in national or international conservation. Secondly, NSS rank does not take into account science and wildlife management limitations or economic, social, or political factors, which are necessary to consider when designing conservation strategies. Lastly, the new NSSU designation deviates from the numerical designation given to other NSS ranks. No differentiation is made between species where population data is lacking and threat levels are known to be increasing, and species with lacking survey data that are not believed to be facing increasing threats.

To address these shortcomings, an SGCN conservation prioritization system was developed. The system was designed to provide a clear and transparent mechanism to focus internal and external conservation efforts toward species where there is the greatest likelihood of preventing future listings under the Endangered Species Act and for which conservation activities will provide the greatest benefits for native species, natural habitats, and the state.

The following six variables were approved by the Wyoming Game and Fish Commission (1/28/2010) to evaluate the conservation priority of SGCN. Descriptions for each variable are found in Appendix A.

1. WGFD NSS rank.
2. Wyoming's contribution to the species' overall conservation.
3. Regulatory/monetary impacts of the species' listing under the Endangered Species Act.
4. Urgency of conservation action.
5. Ability to implement effective conservation actions.
6. The species' ecological or management role as keystone, indicator, or umbrella species.

Numerical scores were assigned to each of these variables and summed to provide a total score. SGCN were placed into one of three tiers based on their total score: Tier I – highest priority, Tier II – moderate priority, and Tier III – lowest priority. Prioritization scores were assigned by two or more WGFD biologists who have considerable knowledge about the SGCN. If the difference in total scores by any two individuals resulted in a species being placed in different tiers, then the relevant variables were

[4] Includes four groups of mollusks and one group of crustaceans.

[5] The 279 SGCN designated in 2005 included 54 mammals, 60 birds, 26 reptiles, 12 amphibians, 40 fishes, 19 crustaceans, and 68 mollusks Of these species, 235 received the SGCN designation either partly or solely because of a lack of sufficient information to adequately assesses their conservation status.

discussed to reach consensus about the appropriate tier for the species. The tier for any SGCN may be reviewed annually if circumstances change or new data becomes available.

Species ranked NSS1 – NSS4 were treated differently than NSSU species. This was due to the lack of sufficient information about NSSU species to adequately assess some prioritization variables and also because of an absence of a numerical NSS rank. The prioritization system for NSS1 – NSS4 and NSSU is as follows:

NSS1 – NSS4

1. The NSS rank of the species is subtracted from 5 and multiplied by 6: [(5-NSS)×6]. This would result in scores of NSS1=24, NSS2=18, NSS3=12, NSS4=6.
2. The species is assigned a score of 1–10 based on the variable "Wyoming's contribution to the species' overall conservation"; 10 being the highest contribution and 1 being the lowest contribution. The WYNDD G rank (global chance of extinction) and Wyoming Conservation Contribution score were consulted in determining this score.
3. The species is assigned a score of 1–5; 5 being highest and 1 the lowest for each of the following variables:
    a. Regulatory/monetary impacts of the species' listing under the Endangered Species Act.
    b. Urgency of conservation action.
    c. Ability to implement effective conservation actions.
    d. The species' ecological or management role as a keystone, indicator, or umbrella species.

    A species ranked NSS 1 – NSS4 has a maximum of 54 points. Species with a total score of 1–18 are Tier III, 19–36 are Tier II, 37–54 are Tier I.

NSSU

1. NSSU species are assigned a score of 1–12 based on the variable "Wyoming's contribution to the species' overall conservation"; 12 being the highest contribution and 1 being the lowest contribution.
2. Next, a score of 1–6 is assigned for each of the following variables; 6 being the highest and 1 the lowest:
    a. Regulatory/monetary impacts of the species' listing under the Endangered Species Act.
    b. Urgency of conservation action

An NSSU species can have a maximum of 24 points. Species with a total score of 1–8 are Tier III, 9–16 are Tier II, and 17–24 are Tier I.

TABLE 3. – Wyoming 2010 SGCN

(SGCN are organized by taxa, conservation, and priority tier and then alphabetized by common name).

Taxa Group	Common Name	Scientific Name	2010 NSS Cell	Tier
Bird	Bald Eagle	*Haliaeetus leucocephalus*	NSS2 (Ba)	I
	Burrowing Owl	*Athene cunicularia*	NSSU (U)	I
	Common Loon	*Gavia immer*	NSS1 (Aa)	I
	Ferruginous Hawk	*Psaltriparus minimus*	NSSU (U)	I
	Great Gray Owl	*Strix nebulosa*	NSSU (U)	I
	Greater Sage-Grouse	*Centrocercus urophasianus*	NSS2 (Ba)	I
	Mountain Plover	*Charadrius montanus*	NSSU (U)	I
	Northern Goshawk	*Accipiter gentilis*	NSSU (U)	I
	American Bittern	*Botaurus lentiginosus*	NSS3 (Bb)	II
	Ash-throated Flycatcher	*Myiarchus cinerascens*	NSS3 (Bb)	II
	American Three-toed Woodpecker	*Picoides dorsalis*	NSSU (U)	II
	Barrow's Goldeneye	*Bucephala islandica*	NSS3 (Bb)	II
	Black-backed Woodpecker	*Picoides arcticus*	NSSU (U)	II
	Black Tern	*Chlidonias niger*	NSS3 (Bb)	II
	Black-crowned Night-heron	*Nycticorax nycticorax*	NSS3 (Bb)	II
	Bobolink	*Dolichonyx oryzivorus*	NSS4 (Bc)	II
	Boreal Owl	*Aegolius funereus*	NSS3 (Bb)	II
	Brewer's Sparrow	*Spizella breweri*	NSS4 (Bc)	II
	Bushtit	*Psaltriparus minimus*	NSS3 (Bb)	II
	Canvasback	*Aythya valisineria*	NSS3 (Bb)	II
	Caspian Tern	*Hydroprogne caspia*	NSS3 (Bb)	II
	Chestnut-collared Longspur	*Calcarius ornatus*	NSS4 (Bc)	II
	Columbian Sharp-tailed Grouse	*Tympanuchus phasianellus columbianus*	NSS4 (Bc)	II
	Dickcissel	*Spiza americana*	NSS4 (Bc)	II
	Forster's Tern	*Sterna forsteri*	NSS3 (Bb)	II
	Franklin's Gull	*Larus pipixcan*	NSS3 (Bb)	II
	Grasshopper Sparrow	*Ammodramus savannarum*	NSS4 (Bc)	II
	Harlequin Duck	*Histrionicus histrionicus*	NSS3 (Bb)	II
	Juniper Titmouse	*Baeolophus ridgwayi*	NSS3 (Bb)	II
	Lark Bunting	*Calamospiza melanocorys*	NSS4 (Bc)	II
	Lesser Scaup	*Aythya affinis*	NSS3 (Bb)	II
	Long-billed Curlew	*Numenius americanus*	NSS3 (Bb)	II
	McCown's Longspur	*Calcarius mccownii*	NSS4 (Bc)	II
	Northern Pintail	*Anas acuta*	NSS3 (Bb)	II
	Peregrine Falcon	*Falco peregrinus*	NSS3 (Bb)	II
	Redhead	*Aythya americana*	NSS3 (Bb)	II
	Sage Sparrow	*Amphispiza belli*	NSS4 (Bc)	II

Taxa Group	Common Name	Scientific Name	2010 NSS Cell	Tier
	Sage Thrasher	*Oreoscoptes montanus*	NSS4 (Bc)	II
	Short-eared Owl	*Asio flammeus*	NSS4 (Bc)	II
	Snowy Egret	*Egretta thula*	NSS3 (Bb)	II
	Trumpeter Swan	*Cygnus buccinator*	NSS2 (Ba)	II
	Virginia Rail	*Rallus limicola*	NSS3 (Bb)	II
	Western Scrub-jay	*Aphelocoma californica*	NSS3 (Bb)	II
	White-faced Ibis	*Plegadis chihi*	NSS3 (Bb)	II
	Black Rosy-Finch	*Leucosticte arata*	NSSU (U)	II
	Brown-capped Rosy-Finch	*Leucosticte australis*	NSSU (U)	II
	Clark's Grebe	*Aechmophorus clarkii*	NSSU (U)	II
	Lewis's Woodpecker	*Melanerpes lewis*	NSSU (U)	II
	Northern Pygmy-Owl	*Glaucidium gnoma*	NSSU (U)	II
	Pygmy Nuthatch	*Sitta pygmaea*	NSSU (U)	II
	Swainson's Hawk	*Buteo swainsoni*	NSSU (U)	II
	Upland Sandpiper	*Bartramia longicauda*	NSSU (U)	II
	Sandhill Crane	*Grus canadensis tabida*	NSS4 (Bc)	III
	Merlin	*Falco columbarius*	NSSU (U)	III
	Willow Flycatcher	*Empidonax traillii*	NSS4 (Cb)	III
	Yellow-billed Cuckoo	*Coccyzus americanus*	NSSU (U)	III
Mammal	Black-footed Ferret	*Mustela nigripes*	NSS1 (Aa)	I
	Canada Lynx	*Lynx canadensis*	NSS1 (Aa)	I
	Townsend's Big-eared Bat	*Corynorhinus townsendii*	NSS2 (Ba)	I
	American Marten	*Martes americana*	NSS4 (Cb)	II
	American Pika	*Ochotona princeps*	NSSU (U)	II
	Big Brown Bat	*Eptisicus fuscus*	NSS4 (Cb)	II
	Bighorn Sheep	*Ovis canadensis*	NSS4 (Bc)	II
	Canyon Mouse	*Peromyscus crinitus*	NSS3 (Bb)	II
	Cliff Chipmunk	*Neotamias dorsalis*	NSS3 (Bb)	II
	Dwarf Shrew	*Sorex nanus*	NSS3 (Bb)	II
	Eastern Red Bat	*Lasiurus borealis*	NSSU (U)	II
	Fringed Myotis	*Myotis thysanode*	NSS3 (Bb)	II
	Great Basin Pocket Mouse	*Perognathus parvus*	NSS3 (Bb)	II
	Hispid Pocket Souse	*Chaetodipus hispidus*	NSS3 (Bb)	II
	Idaho Pocket Gopher	*Thomomys idahoensis*	NSS3 (Bb)	II
	Little Brown Myotis	*Myotis lucifugus*	NSS4 (Cb)	II
	Long-eared Myotis	*Myotis evotis*	NSS3 (Bb)	II
	Long-legged Myotis	*Myotis volans*	NSS3 (Bb)	II
	Moose	*Alces alces*	NSS4 (Bc)	II
	Northern Flying Squirrel	*Glaucomys sabrinus*	NSS4 (Bc)	II
	Northern Myotis	*Myotis septentrionalis*	NSS3 (Bb)	II

Taxa Group	Common Name	Scientific Name	2010 NSS Cell	Tier
	Northern River Otter	*Lontra canadensis*	NSSU (U)	II
	Olive-backed Pocket Mouse	*Parognathus fasciatus*	NSS4 (Cb)	II
	Piñon Mouse	*Peromyscus truei*	NSS3 (Bb)	II
	Plains Harvest Mouse	*Reithrodontomys montanus*	NSS3 (Bb)	II
	Plains Pocket Gopher	*Geomys bursarius*	NSS4 (Bb)	II
	Preble's Meadow Jumping Mouse	*Zapus hudsonicus prebleii*	NSS4 (Bc)	II
	Preble's Shrew	*Sorex preblei*	NSS3 (Bb)	II
	Pygmy Rabbit	*Brachylagus idahoensis*	NSS3 (Bb)	II
	Pygmy Shrew	*Sorex hoyi*	NSS2 (Ab)	II
	Silky Pocket Mouse	*Perognathus flavus*	NSS3 (Bb)	II
	Spotted Bat	*Euderma maculatum*	NSS3 (Bb)	II
	Swift Fox	*Vulpes velox*	NSS4 (Cb)	II
	Water Vole	*Microtus richardsoni*	NSS3 (Bb)	II
	Western Small-footed Myotis	*Myotis ciliolabrum*	NSS4 (Cb)	II
	Wolverine	*Gulo gulo*	NSS3 (Bb)	II
	Wyoming Pocket Gopher	*Thomomys clusius*	NSS3 (Bb)	II
	Fisher	*Mares pennant*	NSSU (U)	III
	Least Weasel	*Mustela nivalis*	NSSU (U)	III
	Pallid Bat	*Antrozous pallidus*	NSS3 (Bb)	III
	Plains Pocket Mouse	*Perognathus flavescens*	NSS3 (Bb)	III
	Hayden's Shrew	*Sorex hayden*	NSS4 (Bc)	III
	Spotted Ground Squirrel	*Spermopholis spilosoma*	NSS4 (Bc)	III
	Uinta Chipmunk	*Neotamias umbrinus*	NSS4 (Bc)	III
	Vagrant Shrew	*Sorex vagrans*	NSS4 (Cb)	III
	Yellow-pine Chipmunk	*Neotamias amoenus*	NSS4 (Bc)	III
Fish	Bluehead Sucker	*Catostomus discobolus*	NSS1 (Aa)	I
	Colorado River Cutthroat Trout	*Oncorhynchus clarkii pleuriticus*	NSS2 (Ba)	I
	Flannelmouth Sucker	*Catostomus latipinnis*	NSS1 (Aa)	I
	Kendall Warm Springs Dace	*Rhinichthys osculus thermalis*	NSS1 (Aa)	I
	Northern Leatherside Chub	*Gila copei*	NSSU (U)	I
	Roundtail Chub	*Gila robusta*	NSS1 (Aa)	I
	Sturgeon Chub	*Macrhybopsis gelida*	NSS1 (Aa)	I
	Yellowstone Cutthroat Trout	*Oncorhynchus clarkii bouvieri*	NSS2 (Ba)	I
	Bonneville Cutthroat Trout	*Oncorhynchus clarkii utah*	NSS3 (Bb)	II
	Burbot	*Lota lota*	NSS3 (Bb)	II
	Finescale Dace	*Phacinus neogaeus*	NSS2 (Ab)	II
	Goldeye	*Hiodon alosoides*	NSS3 (Bb)	II
	Hornyhead Chub	*Nacomis biguttatus*	NSS2 (Ab)	II
	Iowa Darter	*Etheostoma exile*	NSS3 (Bb)	II
	Mountain Whitefish	*Prosopium williamsoni*	NSS4 (Bc)	II

Taxa Group	Common Name	Scientific Name	2010 NSS Cell	Tier
	Pearl Dace	*Margariscus margarita*	NSS2 (Ab)	II
	Plains Minnow	*Hybognathus placitus*	NSS3 (Bb)	II
	Plains Topminnow	*Fundulus sciadicus*	NSS3 (Bb)	II
	Sauger	*Sander canadensis*	NSS3 (Bb)	II
	Shovelnose Sturgeon	*Scaphirhynchus platorynchus*	NSS3 (Bb)	II
	Snake River Cutthroat Trout	*Oncorhynchus clarkii*	NSS4 (Cb)	II
	Suckermouth Minnow	*Phenacobius mirabilis*	NSS2 (Ab)	II
	Western Silvery Minnow	*Hybognathus argyritis*	NSS2 (Ab)	II
	Bigmouth Shiner	*Notropis dorsalis*	NSS4 (Cb)	III
	Brassy Minnow	*Hybognathus hankinsoni*	NSS4 (Bc)	III
	Central Stoneroller	*Campostoma anomalum*	NSS4 (Cb)	III
	Common Shiner	*Luxilus cornutus*	NSS4 (Bc)	III
	Flathead Chub	*Platygobio gracilis*	NSS4 (Bc)	III
	Northern Plains Killifish	*Fundulus kansae*	NSS4 (Cb)	III
	Orangethroat Darter	*Etheostoma spectabile*	NSSU (U)	III
Amphibians	Boreal Toad	*Anaxyrus boreas boreas*	NSS1 (Aa)	I
	Great Basin Spadefoot	*Spea intermontana*	NSSU (U)	I
	Wyoming Toad	*Anaxyrus baxteri*	NSS1 (Aa)	I
	Columbia Spotted Frog	*Rana luteiventris*	NSS3 (Bb)	II
	Woodfrog	*Lithobates sylvaticus*	NSS2 (Ba)	II
	Great Plains Toad	*Anaxyrus cognatus*	NSSU (U)	III
	Northern Leopard Frog	*Lithobates pipiens*	NSSU (U)	III
	Plains Spadefoot	*Spea bombifrons*	NSSU (U)	III
Reptile	Midget Faded Rattlesnake	*Crotalus oreganus concolor*	NSS1 (Aa)	I
	Black Hills Red-bellied Snake	*Storeria occipitomaculata pahasapae*	NSSU (U)	II
	Great Basin Gophersnake	*Pituophis catenifer deserticola*	NSS2 (Ba)	II
	Northern Rubber Boa	*Charina bottae*	NSS3 (Bb)	II
	Northern Tree Lizard	*Urosaurus ornatus wrighti*	NSS1 (Aa)	II
	Pale Milksnake	*Lampropeltis triangulum multistriata*	NSS3 (Bb)	II
	Plains Black-headed Snake	*Tantilla nigriceps*	NSSU (U)	II
	Plains Gartersnake	*Thamnophis radix*	NSSU (U)	II
	Plains Hog-nosed Snake	*Heterodon nasicus*	NSSU (U)	II
	Prairie Lizard	*Sceloporus consobrinus*	NSSU (U)	II
	Prairie Racerunner	*Aspidoscelis sexlineatus viridis*	NSSU (U)	II
	Red-Sided Gartersnake	*Thamnophis sirtalis parietalis*	NSSU (U)	II
	Smooth Greensnake	*Opheodrys vernalis*	NSS3 (Bb)	II
	Valley Gartersnake	*Thamnophis sirtalis fitchi*	NSSU (U)	II
	Great Basin Skink	*Plestiodon skiltonianus utahensis*	NSSU (U)	III
	Great Plains Earless Lizard	*Holbrookia maculata maculata*	NSSU (U)	III
	Greater Short-horned Lizard	*Phrynosoma hernandesi*	NSS4 (Bc)	III

Taxa Group	Common Name	Scientific Name	2010 NSS Cell	Tier
	Northern Many-lined Skink	*Plestiodon multivirgatus multivirgatus*	NSSU (U)	III
	Ornate Box Turtle	*Terrapene ornata ornata*	NSSU (U)	III
	Western Painted Turtle	*Chrysemys picta bellii*	NSS4 (Bc)	III
	Western Spiny Softshell	*Apalone spinifera hartwegi*	NSS4 (Bc)	III
Crustaceans	Pilose Crayfish	*Pacifastacus gambelii*	NSSU (U)	II
	Calico Crayfish	*Orconectes immunis*	NSS4 (Bc)	III
	Devil Crayfish	*Cambarus diogenes*	NSSU (U)	III
	Fairy and Tadpole Shrimps	*Combined account*	NSSU (U)	III
	Ringed Crayfish	*Orconectes neglectus*	NSSU (U)	III
Mollusks	Jackson Lake Springsnail	*Pyrgulopsis robusta*	NSSU (U)	I
	Mountain Snails	Combined account	NSSU (U)	I
	Aquatic Snails	Combined account	NSSU (U)	II
	California Floater	*Anodonta californiensis*	NSSU (U)	II
	Cave Physa	*Physella spelunca*	NSSU (U)	II
	Cylindrical Papershell	*Anodontoides ferussacianus*	NSSU (U)	II
	Fatmucket	*Lampsilis siliquoidea*	NSSU (U)	II
	Giant Floater	*Pyganodon grandis*	NSSU (U)	II
	Land Snails	Combined account	NSSU (U)	II
	Plain Pocketbook	*Lampsilis cardium*	NSSU (U)	II
	Western Pearlshell	*Margaritifera falcata*	NSSU (U)	II
	White Heelsplitter	*Lasmigona complanata*	NSSU (U)	II
	Pill Clams	Combined account	NSSU (U)	III
	Stagnicola Pondsnails	Combined account	NSSU (U)	III

SGCN Accounts and Database

Each SGCN is included in the SWAP and has a species account that provides information on the species and its conservation needs. A database was created to store this information as part of the 2010 revision of the SWAP. The database is intended to advance SGCN conservation efforts by facilitating the updating, searching, reporting, tracking, and sharing of information. In the future, the database may be expanded to include information on non-SGCN species. Database applications may eventually include an interactive web-based feature to allow other agencies and the public to query information about Wyoming's SGCN.

Information for species accounts was provided by the WGFD biologists who are most familiar with the species. Drafts of mammal and bird species accounts were reviewed by the WGFD's Supervisor of Biological Services; fish, amphibian, and reptile species accounts were reviewed by the Fisheries Management Coordinator. Species accounts were also made available to WYNDD for additional input.

Species Accounts are alphabetized by common name. At present, each species account includes the following information:

- The species' common and scientific name.
- Abundance – Abundant, Common, Uncommon, Unknown.
- Status – WGFD NSS rank with an explanation of matrix row (limiting factor) and column (population status) classification, NatureServe G rank (global chance of extinction), and WYNDD S rank (state chance of extinction).
- Introduction – information on the species' continental and Wyoming distributions and history in Wyoming, including current and past management activities, legal status, and life history information.
- Habitat – habitat locations and characteristics.
- Problems – list of threats to the species or its habitat.
- Conservation Action – actions needed for the long term conservation of the species in Wyoming.
- Monitoring/Research – information on both existing and needed monitoring and research to evaluate the species' population status and the effectiveness of conservation actions.
- Recent developments – recent conservation activities, research, policy direction, or legal decisions that have bearing on the future conservation of the species.
- Reference – literature cited within the species account, as well as leading research and conservation plans.
- Range and Distribution Maps – WYNDD and WGFD worked collaboratively to update range and distribution maps for SGCN.

SGCN Range Maps

For the purposes of the SWAP, range was defined as the best estimate of the total geographic space thought to be occupied by an individual species in Wyoming. The first step in creating SGCN range maps was to reference a set of North American range maps compiled by NatureServe (http://www.natureserve.org/getData/animalData.jsp). These maps were essentially hand-drawn polygons representing a compilation of published continental-scale range maps for each species. These maps were then modified to fit high-resolution, 10-digit watershed (HUC) boundaries from the National Hydrography Dataset (Simley and Carswell 2009). This step provided a common spatial unit—the 10-digit HUC—for all SGCN range maps.

The HUC-based range maps were then reviewed and modified by WYNDD zoologists to accommodate local knowledge and documented occurrences maintained in the

WYNDD Biotics Database and the WGFD Wildlife Observation System (WOS). A series of meetings was then convened to allow state and regional experts to provide detailed comments and modifications. Reptile and amphibian meetings were held May 26 – 27, 2009; bird meetings were held September 14 – 15, 2009; and mammal meetings were held September 15 – 16, 2009. Representatives from the WGFD and WYNDD attended all meetings, and representatives from other organizations (e.g., USDA Forest Service, USDI Bureau of Land Management, regional universities, environmental consultants, and regional non-profit groups) were present at some meetings. The occurrence of a species within each watershed was classified into five categories: Known Recent Resident, Suspected Recent Resident, Accidental Occupant, Historical Resident, or Never a Resident. For SWAP SGCN range mapping purposes, "Known Recent Resident" and "Suspected Recent Resident" HUCs were considered to be within a species' range,[6] while "Accidental Occupant," "Historical Occupant," and "Never a Resident" HUCs were considered outside a species' range. Species ranges were mapped as the combined boundaries of "Known Recent Resident" and "Suspected Recent Resident" HUCs. Additional information about the SGCN range mapping process can be found in Keinath et al. (2010a).

SGCN Distribution Maps

For the purposes of the SWAP, distribution is defined as a spatial subset of range. It refers to environments within a species' range that are suitable for that species' occupation. In contrast to "range," which considers species presence based solely on geographic space, "distribution" considers habitats where species could occur based on measured environmental characteristics. Given incomplete knowledge of species occurrence for most SGCN, species distributions were estimated by modeling suitable environments. The distribution model for a given SGCN was created by first attributing points of known occurrence for that species with multiple environmental measurements (e.g., elevation, mean annual precipitation, vegetation type), then by extrapolating this data to identify similar environments across Wyoming using established statistical techniques (e.g., Beauvais et al. 2006).

Points of known occurrence were obtained from the WYNDD Biotics Database, the WGFD WOS, and several ancillary datasets compiled by WYNDD specifically for this effort. These sources resulted in roughly 270,000 SGCN locations, which were systematically evaluated and filtered for accuracy and consistency following methods developed at WYNDD (Keinath et al. 2010b). Environmental measurements were derived from a variety of publically available sources and generally fell within six major categories: climate, hydrology, land cover, landscape structure, substrate, and terrain. Details on these sources of information and how they were applied to distribution maps can be found in Keinath et al. (2010b).

Maximum Entropy methods were used to select important environmental variables and summarize the environment at points of known SGCN occurrence (Phillips et al. 2006, Phillips and Dudik 2008, Keinath et al. 2010b). The result is a continuous model that estimates, for 30-meter cells across Wyoming, the probability of that cell being suitable habitat for the SGCN in question. To create maps for the SWAP, a binary threshold was specified that divided the continuous output into two categories: predicted presence and predicted absence.

The quality of distribution models was evaluated using multiple methods, both quantitative and qualitative, including prediction accuracy based on ten-fold cross-validation, statistics derived

[6] "Known Recent Resident" indicates that the species is known to occur in a watershed based on recently documented observations and/or the knowledge of expert range mapping participants. Observations made in 1985 or later qualified as recent. "Suspected Recent Resident" indicates that range mapping participants were not aware of any recent (i.e., 1985 or later) observations of a species in a watershed, but they believed the species to occur in the watershed at the time of mapping based on species characteristics and probable suitability of habitat within the watershed.

from receiver-operating characteristic analyses, evaluations of input data quality, and the expert opinion of biologists regarding how well final models reflected their understanding of species' distributions (Fielding and Bell 1997, Freeman and Moisen 2008). Validation statistics are provided for each SGCN by Keinath et al. (2010b).

Range maps tend to overestimate where a species occurs, since range polygons generally include some unsuitable habitat. In contrast, locations of documented occurrence usually drastically underestimate where a species occurs, particularly when systematic survey efforts are lacking, as is the case for most SGCN. For example, some small-mammal and reptile SGCN have ranges encompassing more than half of Wyoming, while there are only a handful of documented occurrences in the state. Distribution models are intended to bridge this gap by using occurrence data to quantify the environments where a species is known to occur and spatially map similar areas within that species' range. Thus, distribution maps identify areas where a species could potentially occur based on current information and should not be interpreted as depicting known occurrence. Models are only as good as the data used to create them, so models with few known occurrences and/or poor validation statistics (Keinath et al. 2010b) should be used with caution. Further, SGCN distribution models were created at the state-level scale and are only suitable for analyses conducted at a similar scale, such as identifying coarsely-defined areas of conservation concern or quantifying state-wide patterns of potential distribution.

SGCN Monitoring

The 2005 CWCS placed the highest priority on completing sufficient inventories on those SGCN whose status could not be adequately documented in Wyoming. Bird and mammal SGCN are reviewed annually by the Terrestrial Nongame Section of the WGFD. Species with sufficient distribution and general abundance data to indicate status are included in the "inventories adequate" ranking total. However, any species that has limiting factors which appear to be increasing in severity, or that has been petitioned for listing under the ESA must have a system implemented for monitoring population trends before it is included in the adequate ranking category. If such a monitoring program is lacking, WGFD develops proposals and solicits needed funding but does not include them in the adequate count.

The WGFD developed a timeline to complete sufficient inventories to evaluate, strengthen the current knowledge of, and potentially reclassify the status of, 34 of 40 fishes, 57 of 114 birds and mammals, 8 of 12 amphibians, and 15 of 26 reptiles identified as sensitive, by 2014. All sensitive species inventory work is planned to be completed by 2020. As of July 2010, 24 of 54 (44 percent) of the mammals, 55 of 60 (91 percent) birds, 2 of 26 (8 percent) reptiles, 4 of 10 (33 percent) amphibians, and 25 of 40 (63 percent) fishes,.and none of the 19 crustaceans or 68 mollusks had sufficient inventory data to document their security in Wyoming.

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Appendix A

SGCN Prioritization Variable Descriptions

Descriptions are not intended to be exclusive, but to serve as a guide regarding the type of information that should be considered in providing a prioritization score.

WGFD NSS Rank – the Wyoming Game and Fish Department (WGFD) Native Species Status (NSS) rank is an evaluation of the Wyoming population status of a species, including its size and distribution, versus limiting factors such as habitat availability and intensity of threats. NSS rank also indentifies species where there is a lack of information to adequately assess conservation status.

Regulatory/Monetary Impacts – extent of potential regulatory or monetary impacts of a species' listing under the Endangered Species Act (ESA).

Consideration could include:

1. Size of the species' range and overlap with other land uses.
2. Current economic contribution of the species (both consumptive and non-consumptive).
3. Type of restrictions necessary to address the species' conservation needs.

Urgency of Conservation Action – accounts for issues associated with the immediacy of the need for conservation action. This variable would capture issues that either occurred subsequent to the designation of the species' NSS rank or that were not considered. These issues may include:

1. New threats.
2. Increases in severity of existing threats.
3. New data that show a significant, persistent decline in the species' population, distribution, or habitat.
4. Likelihood and immediacy of potential ESA listing.
5. Funding or partnership opportunities that are time limited.

Wyoming's Contribution to the Species' Overall Conservation – this variable would address the significance of the role that Wyoming would likely play in the species' overall conservation. It would take into consideration:

1. The Wyoming Natural Diversity Database (WYNDD) G rank (global chance of extinction) and Wyoming Conservation Contribution score.
2. The proportion of the species' overall range that is in Wyoming.
3. The health and size of the species' population in Wyoming compared to those in other portions of its range.
4. Population status and level of conservation activity in surrounding states and other portions of the species' range.

Ability to Implement Effective Conservation Actions – the ability to achieve quantifiable beneficial outcomes in stopping or reversing population declines for the species in Wyoming. This variable includes an evaluation of statutory, scientific, or technological limitations in reversing leading population and habitat threats.

The species' ecological or management role as a keystone, indicator species, or umbrella species. Indicator species are those species

whose population status is a good indicator of the overall health of the habitat it occupies. A keystone species is a species that plays a significant role in shaping and defining the habitat in which it lives. Umbrella species are species selected for making conservation-related decisions, typically because protecting these species indirectly protects the many other species that make up the ecological community of its habitat.

Appendix B

Taxonomy of SGCN Bird and Mammals

Mammals

The Wyoming Game and Fish Department uses the Revised Checklist of North American Mammals North of Mexico (Baker et al. 2003) as the taxonomic reference for mammals in Wyoming. The checklist, first published in 1973, undergoes periodic review and summarizes taxonomic changes that have occurred in the recognized mammalian fauna of North America. According to the checklist, the taxonomy of several mammalian groups remains unresolved at the species level; consequently it is difficult to provide support for elevating subspecies to specific status. Therefore, the WGFD gives no consideration to specific subspecies in Wyoming at this time, except for the Preble's meadow jumping mouse (*Zapus hudsonius preblei*). The taxonomy issue was resolved following the publication of the checklist by King et al. (2006); consequently this subspecies warrants specific status in this revised SWAP.

Baker, R.J., L. C. Bradley, R. D. Bradley, J. W. Dragoo, M. D. Engstrom, R. S. Hoffman, C. A. Jones, F. Reid, D. W. Rice, and C. Jones. 2003. Revised checklist of North American mammals north of Mexico, 2003. Museum of Texas Tech University. Occasional papers 229.

King, T.L., M. S. Eackles, and C.C. Young. 2006. Microsatellite DNA markers for assessing phylogeographic and population structure in Preble's meadow jumping mice (*Zapus hudsonius preblei*) and cross-amplification among neighbouring taxa. Molecular Ecology 6:670-673.

Birds

The American Ornithologists' Union (AOU) Check-list of North American Birds, 7th Edition (AOU 1988) is the official source on the taxonomy of the birds of North and Middle America. In addition, AOU Supplements to the Check-list provide annual updates based on the most recent scientific findings, and are published each July in the scientific journal *The Auk*. The Check-list of North American Birds and its supplements are produced by the AOU's North American Classification Committee (NACC), whose mission is to keep abreast of the systematics and distribution of the birds of North and Middle America in order to create a standard classification. The NACC favors using more than one area of evidence over single data sets for taxonomic changes at species and higher levels (e.g., multiple genetic loci, or genes plus other traits), and prefers to act conservatively in its treatments of taxonomy and nomenclature. Thus, without supporting data, the NACC may reject proposals that cause instability or that suggest taxonomic change without strong substantiation.

The Wyoming Game and Fish Department uses the AOU Check-list of North American Birds, along with its annual supplements, as the definitive source for avian scientific and common names, species codes, subspecies delineations, and order in which species appear on the official State list. Currently, there are no occurrences of avian subspecies in Wyoming that would alter the Species of Greatest Conservation Need Tier ranking.

American Ornithologists' Union. 1983. Check-list of North American Birds. 7th edition. American Ornithologists' Union, Washington, D.C.

Appendix B
SGCN Changes from 2005 CWCS

	Birds	Mammals	Fish	Reptiles	Amphibians	Mollusks	Crustaceans
New research or survey information			Added Brassy Minnow Northern Plains Killifish Removed Lake Chub Longnose Sucker Quillback			Added Calico Crayfish	
Grouping little known mollusks and crustaceans						Added Aquatic Snails[i] Land Snails[ii] Oreohelix Mountain Snails[iii] Pill Clams Stagnicola Pondsnails[iv]	Added Shrimp[v]
Naturally restricted Wyoming population but regionally secure.	Removed American White Pelican Great Blue Heron Scott's Oriole Western Grebe	Removed Abert's Squirrel Black-tailed Prairie Dog Meadow Jumping Mouse		Removed Plateau Fence Lizard Prairie Rattlesnake	Removed American Bullfrog Tiger Salamander		

	Birds	Mammals	Fish	Reptiles	Amphibians	Mollusks	Crustaceans
NSS rank change resulting from revised matrix		Added American Pika Uinta Chipmunk Yellow-pine Chipmunk Removed Grizzly Bear Hoary Bat Prairie Vole Sagebrush Vole Silver-haired Bat Water Shrew Western-heather Vole White-tailed Prairie Dog	Removed Black Bullhead Channel Catfish Mottled Sculpin Mountain Sucker River Carpsucker Shorthead Redhorse Stonecat Paiute Sculpin	Removed Bull Snake Eastern yellow-belly Racer Northern Sagebrush Lizard Wandering Gartersnake	Removed Boreal Chorus Frog Rocky Mountain Toad		
Outside of WGFD jurisdiction			Removed Arctic Grayling Westslope Cutthroat				
Recently discovered undocumented species				Added Great Basin Skink			
Taxonomic change		Added Preble's Meadow Jumping Mouse		Removed Common Gartersnake			
Not NN1-4, NSSU		Removed Uinta Ground Squirrel Wyoming Ground Squirrel					

[i] Mud Amnicola, Rocky Mountain Duskysnail, Fragile Ancylid, Creeping Ancylid, Green River Pebblesnail, Ashy Pebblesnail, Dusky Fossaria, Rock Fossaria, Golden Fossaria, Pygmy Fossaria, Disc Gyro, Star Gyro, Ash Gyro, Two-ridge Rams-horn, Great Basin Rams-horn, Cloaked Physa, Glass Physa, Pumpkin Physa, Rotund Physa, Olive Physa, Tadpole Physa, Pewter Physa, Protean Physa, Rocky Mountain Physa, Utah Physa, Meadow Rams-horn, Rough Rams-horn, Marsh Rams-horn, Sharp Sprite, Umbilicate Sprite, Ribbed Dagger, Bear Lake Springsnail, Indecisive Vallonia, Glossy Valvata, and Mossy Valvata.

[ii] Lance Aplexa, Sierra Ambersnail, Slope Ambersnail, Striate Disc, Niobrara Ambersnail, Callused Vertigo Snail, and Vertigo Paradoxa (a terrestrial snail).

[iii] Keeled Mountain Snail, Mineral Creek Mountain Snail, Pygmy Mountain Snail, Rocky Mountain Snail, Berry's Mountain Snail, Cooper's Rocky Mountain Snail, a land snail (Hells Canyon), and Morgan Creek Mountain Snail.

[iv] Stagnicola Pondsnails, Abbreviate Pondsnail, Fat-whorled Pondsnail, Wrinkled Marshsnail, Woodland Pondsnail, Marsh Pondsnail, Rustic Pondsnail, Mountain Marshsnail , and Widelip Pondsnail.

[v] San Francisco Brine Shrimp, Pocked Pouch Fairy Shrimp, Colorado Fairy Shrimp, Giant Fairy Shrimp, Versitle Fairy Shrimp, Rock Pool Fairy Shrimp, Circumpolar Fairy Shrimp, Eastern Alkali Fairy, Shrimp, Knobbedlip Fairy Shrimp, Ethologist Fairy Shrimp, Lemon Tadpole Shrimp, New Mexico Fairy Shrimp, Crenatethumb Fairy Shrimp, Greater Plains Fairy Shrimp, Beavertail Fairy Shrimp, and Longtail Tadpole Shrimp.

PROJECT REVIEW: MSTI REVIEW GROUP

September 12, 2011 | Helena, Montana

Western Environmental Law Center

SONORAN INSTITUTE

HEADWATERS ECONOMICS

FUTURE WEST

CRAIGHEAD INSTITUTE

Purpose of Spatial Model

- To Provide a Transparent, Objective, and Quantitative Analysis for Siting Potential Transmission Corridors (not routes)
- Incorporate Best Available Science and Expertise to Identify Corridors With Least Accumulated Impact on Wildlife and Community Values

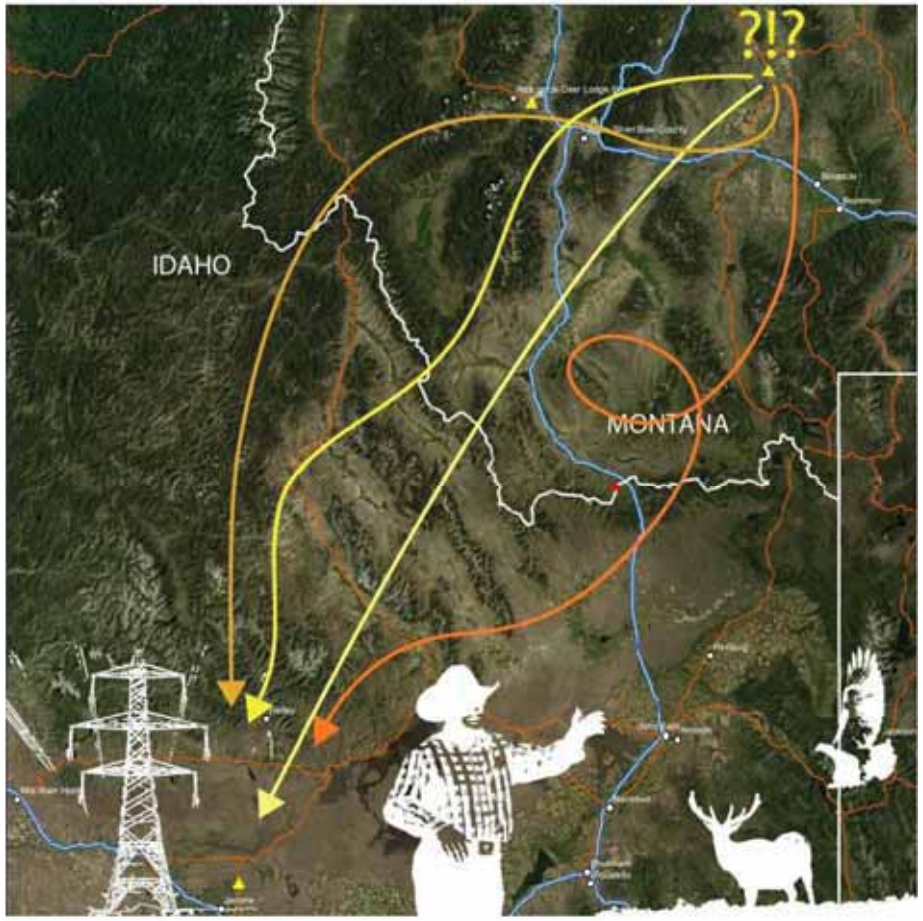
Does Not Replicate Regulatory and EIS Processes

- Regulatory
  - A patchwork of laws and regulations designed for many purposes
  - Represents compromise among multiple, often competing, stakeholders
  - Our models focus on wildlife and community values regardless of regulation – but account for "no-go" areas
- EIS
  - Evaluates and compares *actual* environmental impacts of proposed action and alternatives
  - Our models weight *relative* effects based on perceived and documented sensitivities among all possible routes
- Mitigation
  - Off-site increases $ costs but does not reduce on-site impacts
  - On-site impractical to parameterize for entire cost surface

Decision Support Tool: Proof of Concept

- Proof of Concept – Nothing is set in stone
- Costs refer to potential changes to wildlife or habitat function or relative importance to community – Not $

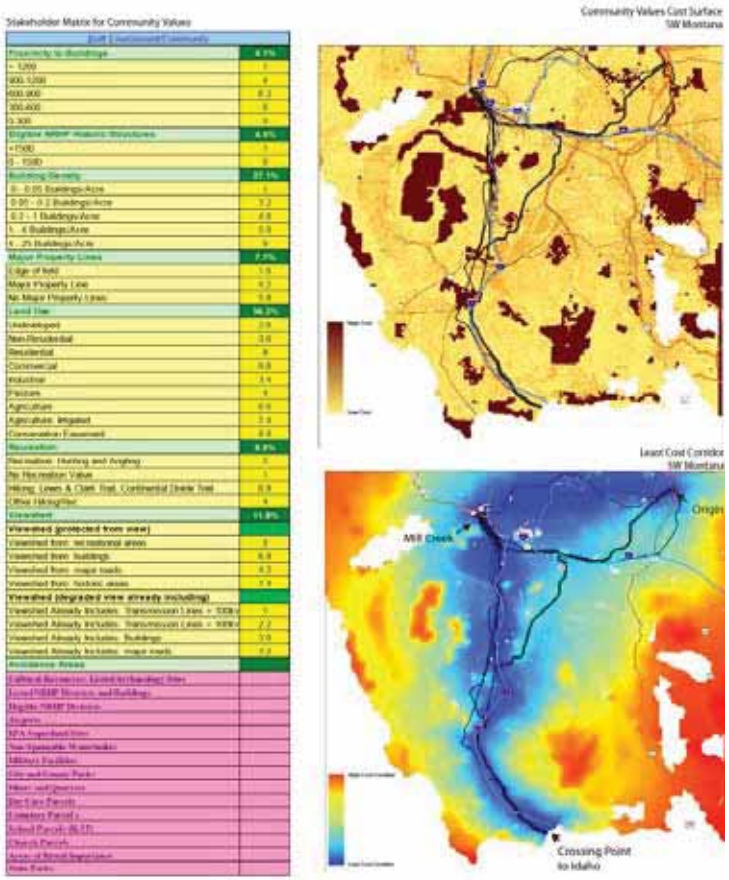
How to choose the most defensible route across a sensitive landscape?



Engineering Community Wildlife

www.MSTIReviewProject.org

Use local community values to inform and comment on routing options.



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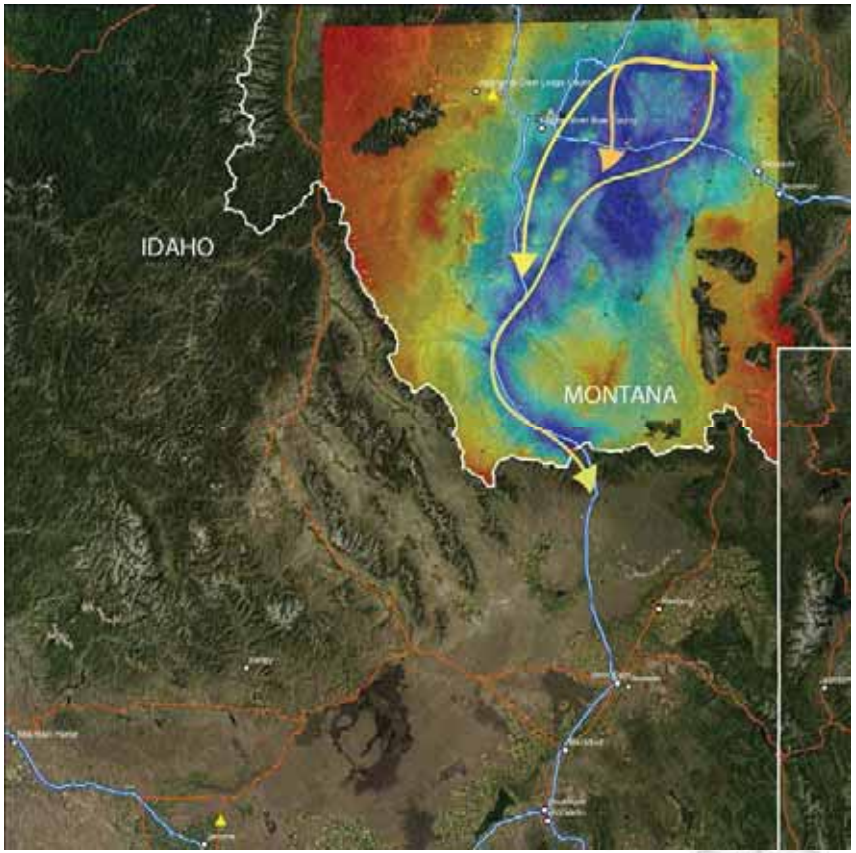

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Community Values
Renewable Energy Transmission Siting Methodology
SPATIAL MODEL
cellis@sonoraninstitute.org

hypothetical study area

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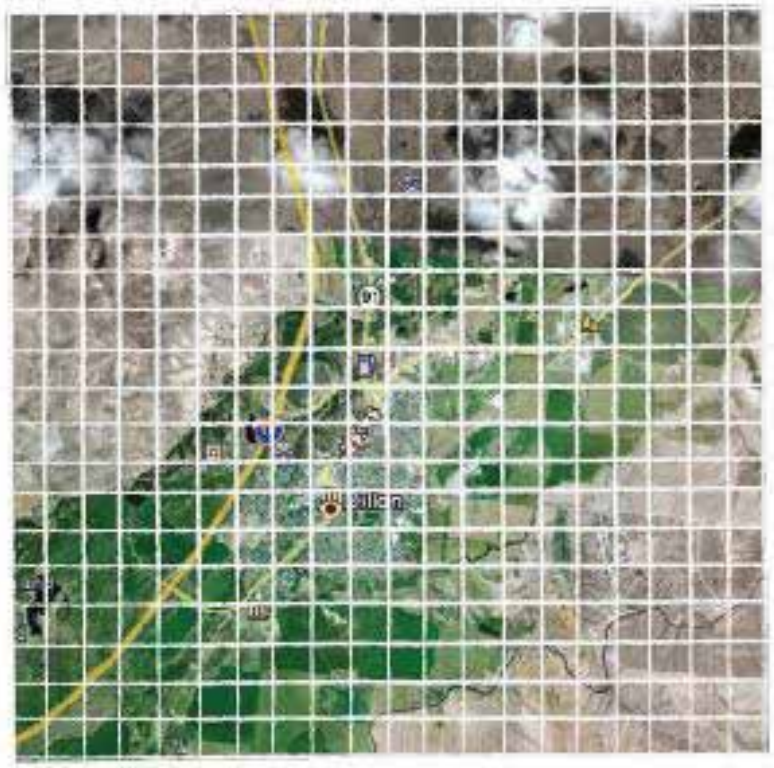
Community Values
Renewable Energy Transmission Siting Methodology
SPATIAL MODEL
cellis@sonoraninstitute.org



90meter grid cells

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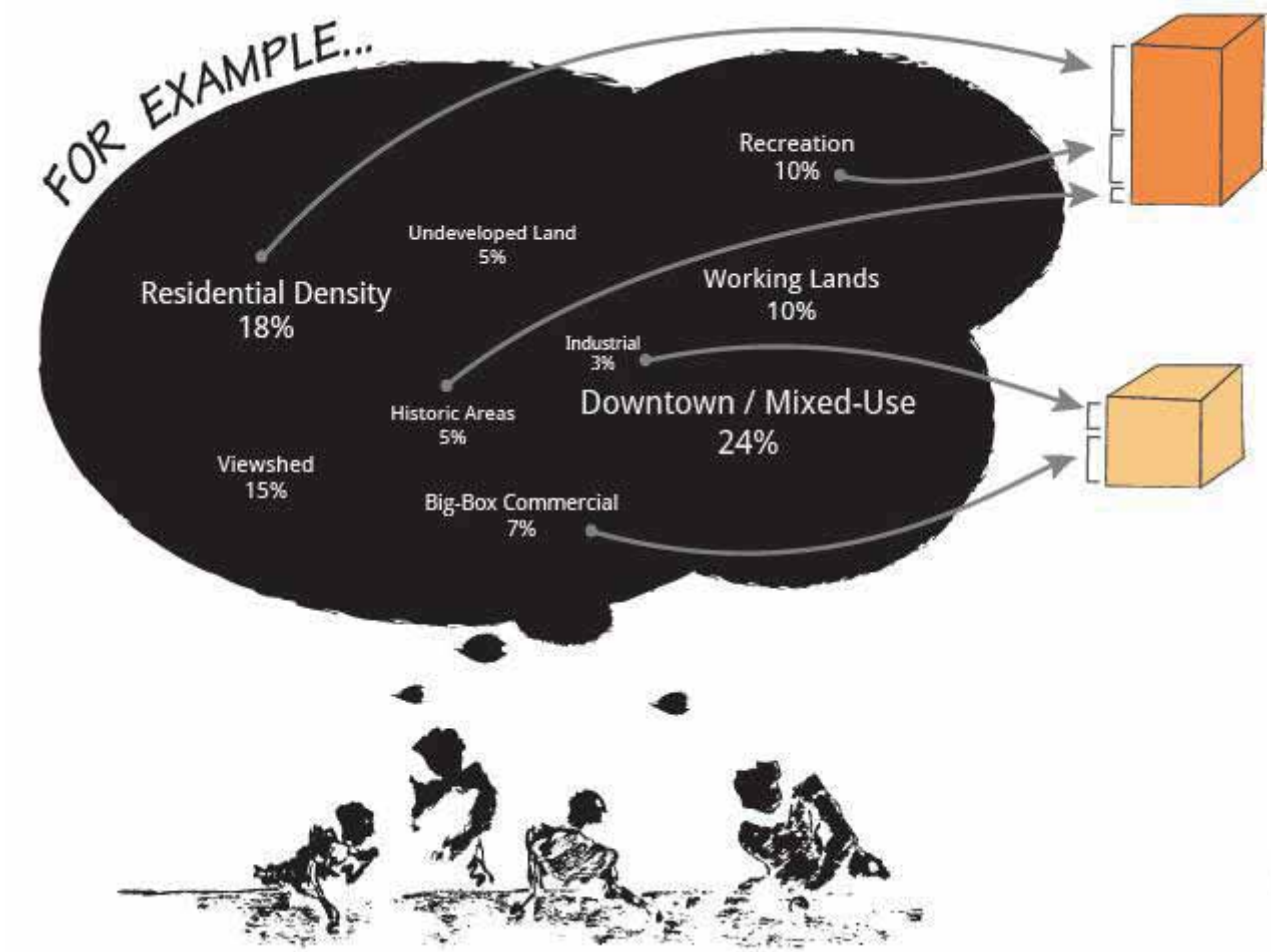
Community Values

Renewable Energy Transmission Siting Methodology

SPATIAL MODEL

cells@sonoraninstitute.org

Identify and prioritize community values



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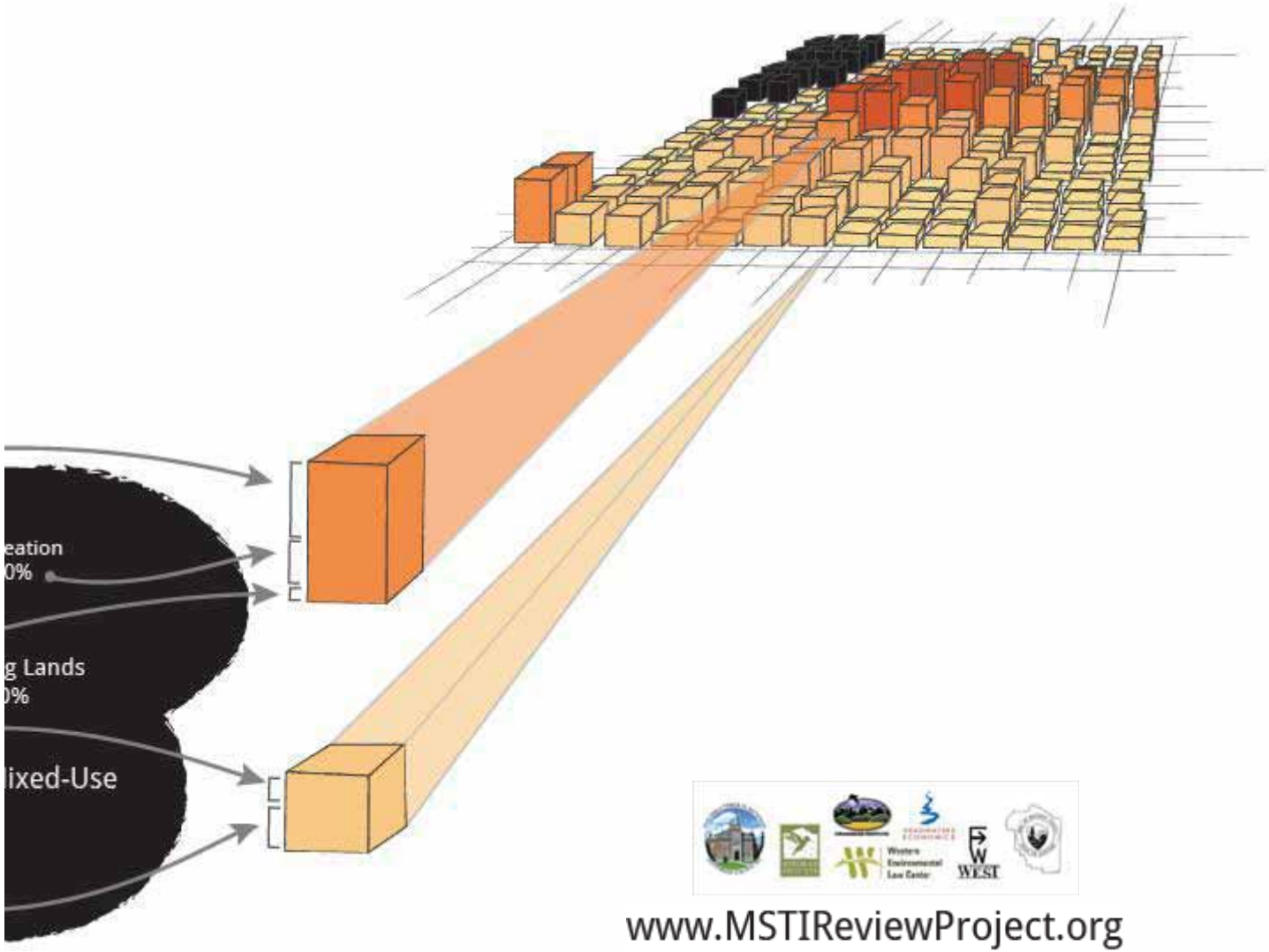
Community Values
Renewable Energy Transmission Siting Methodology
SPATIAL MODEL
cellis@sonoraninstitute.org

Map those values, building a GIS layer that quantifies community values across the entire study area.



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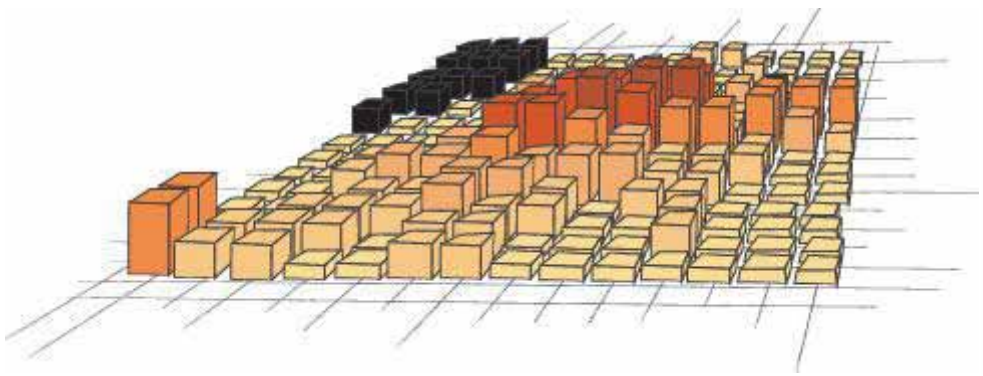

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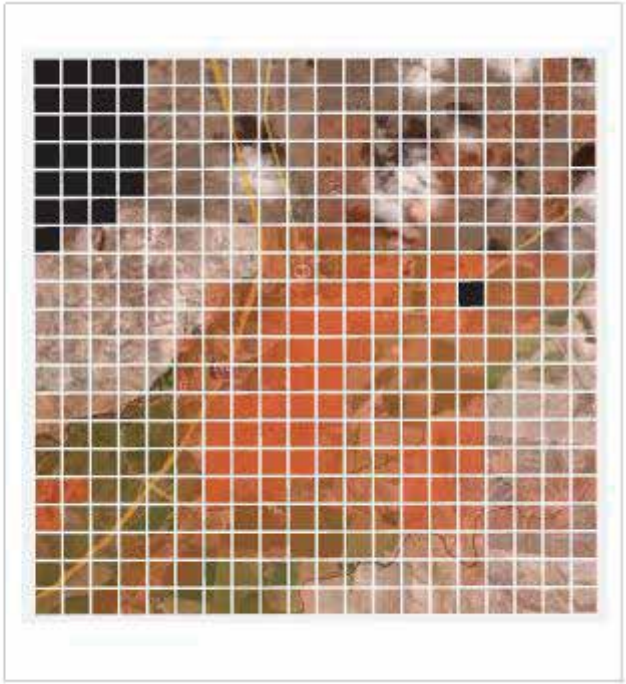

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Community Values

Renewable Energy Transmission Siting Methodology

SPATIAL MODEL

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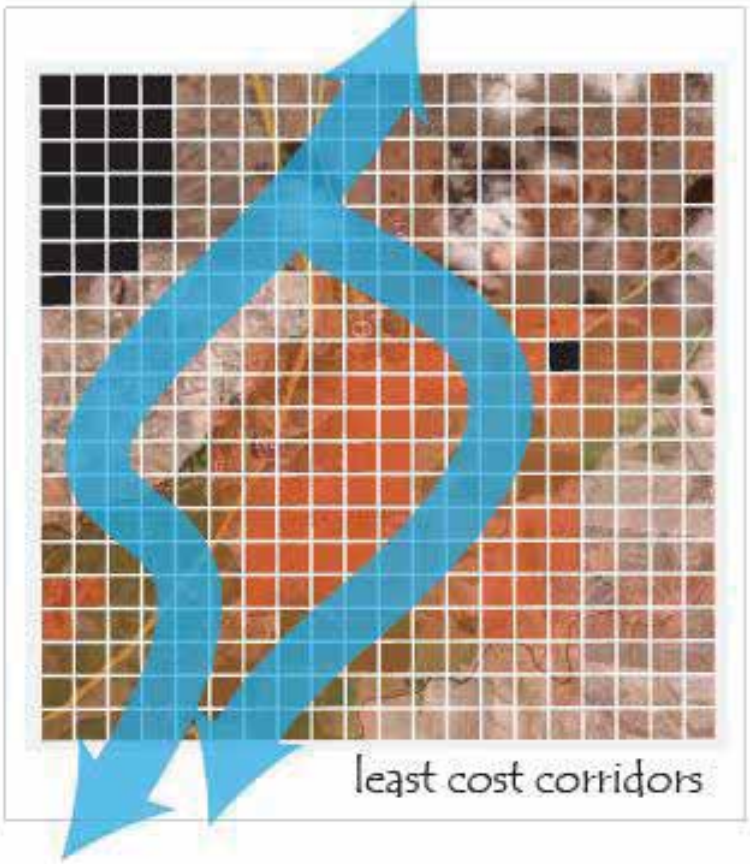
Use those quantified and mapped values to identify "least cost" corridors across the map



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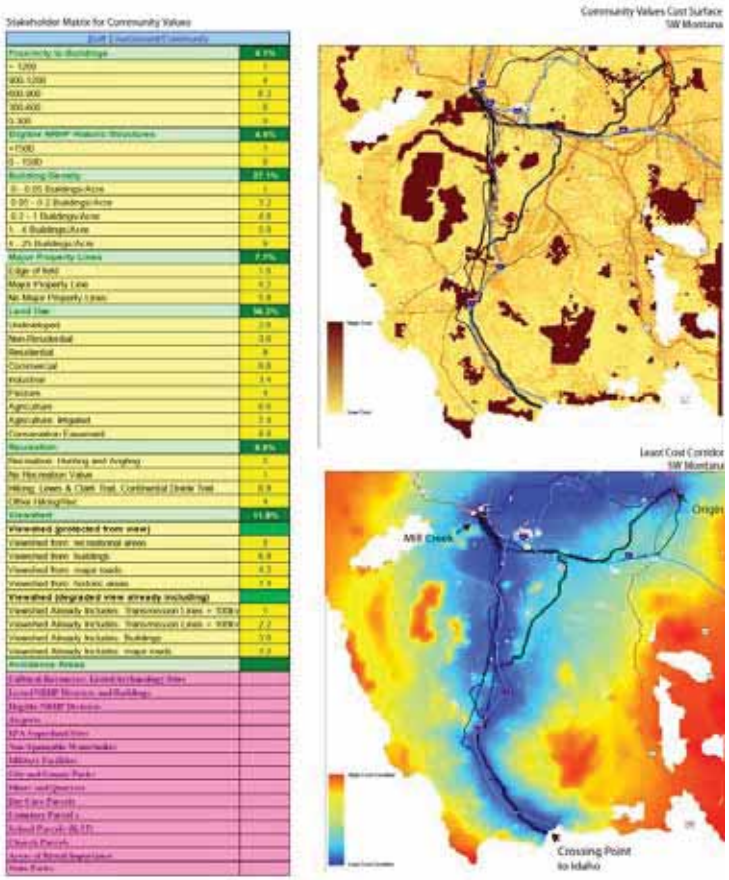

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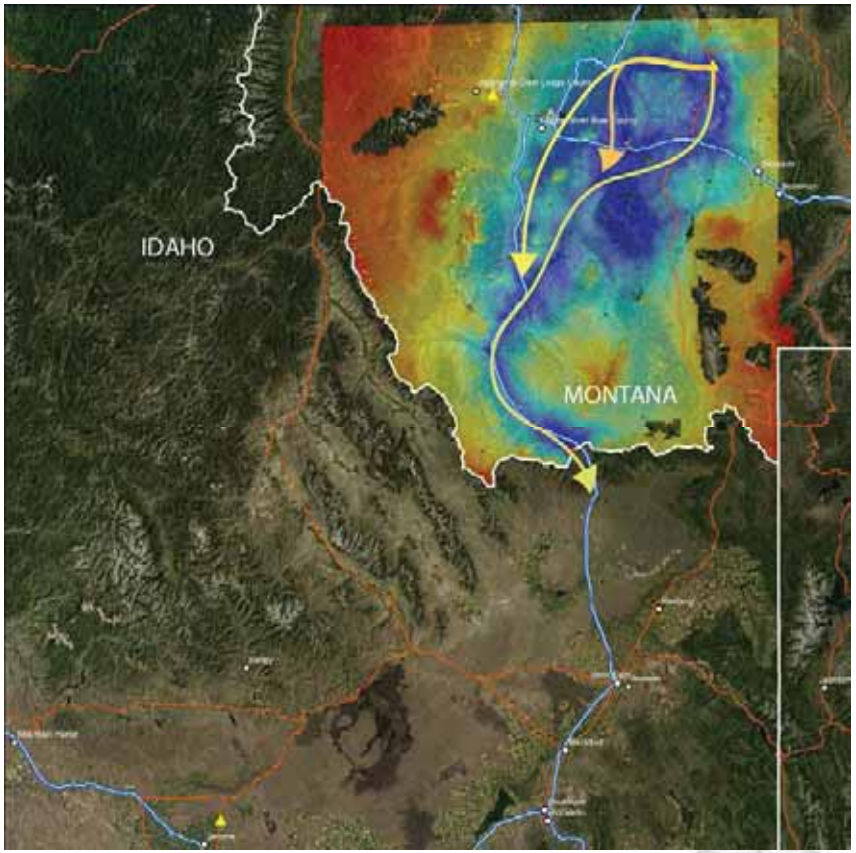

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Community Values
Renewable Energy Transmission Siting Methodology
SPATIAL MODEL

cellis@sonoraninstitute.org

Decision Support Tool: Wildlife

Potential Costs:
Loss of Habitat or Habitat Function

Existing Costs:
Loss of Habitat or Habitat Function From Existing Development or Land Use

⇒

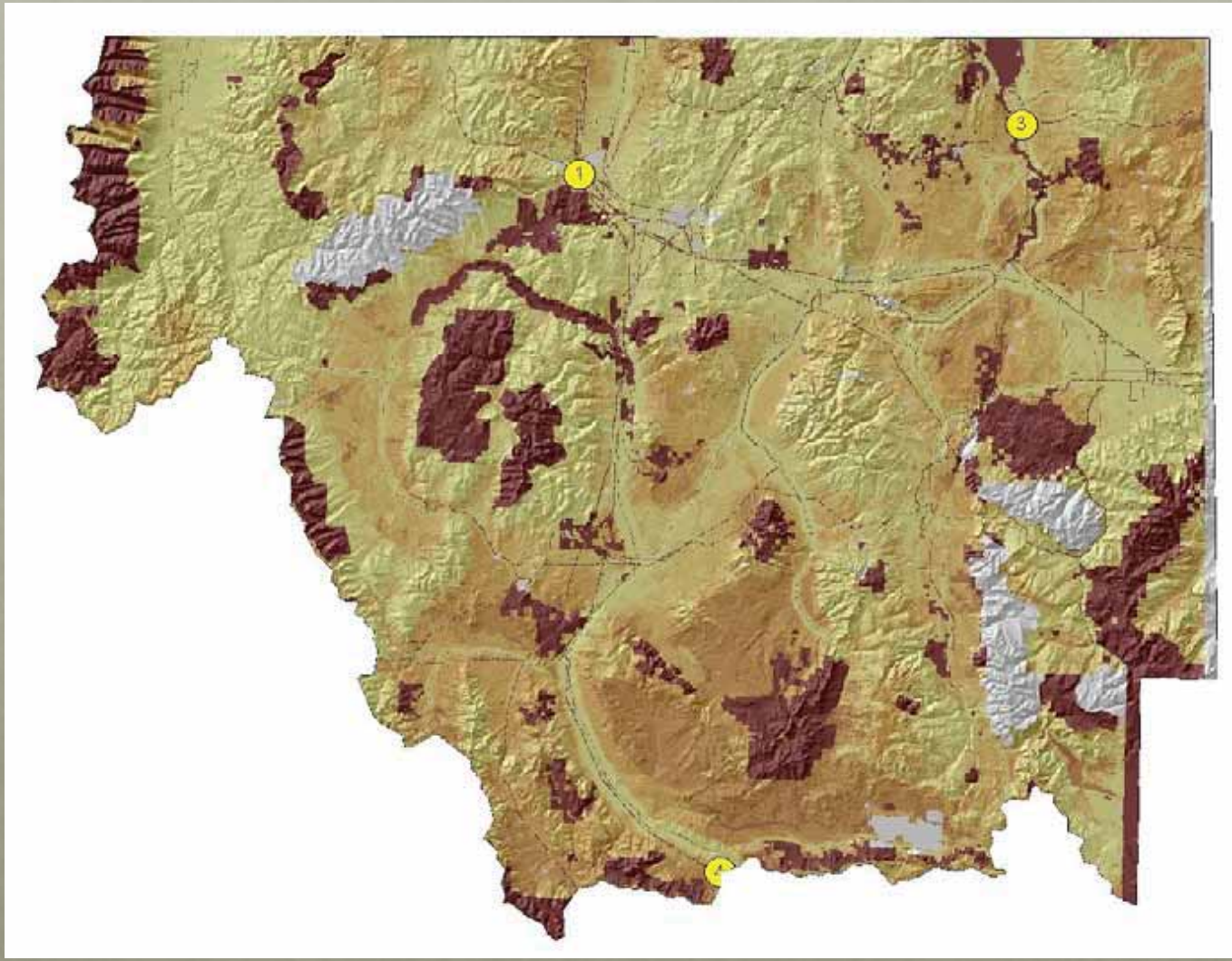
Actual Costs

DECISION SUPPORT TOOL: WILDLIFE

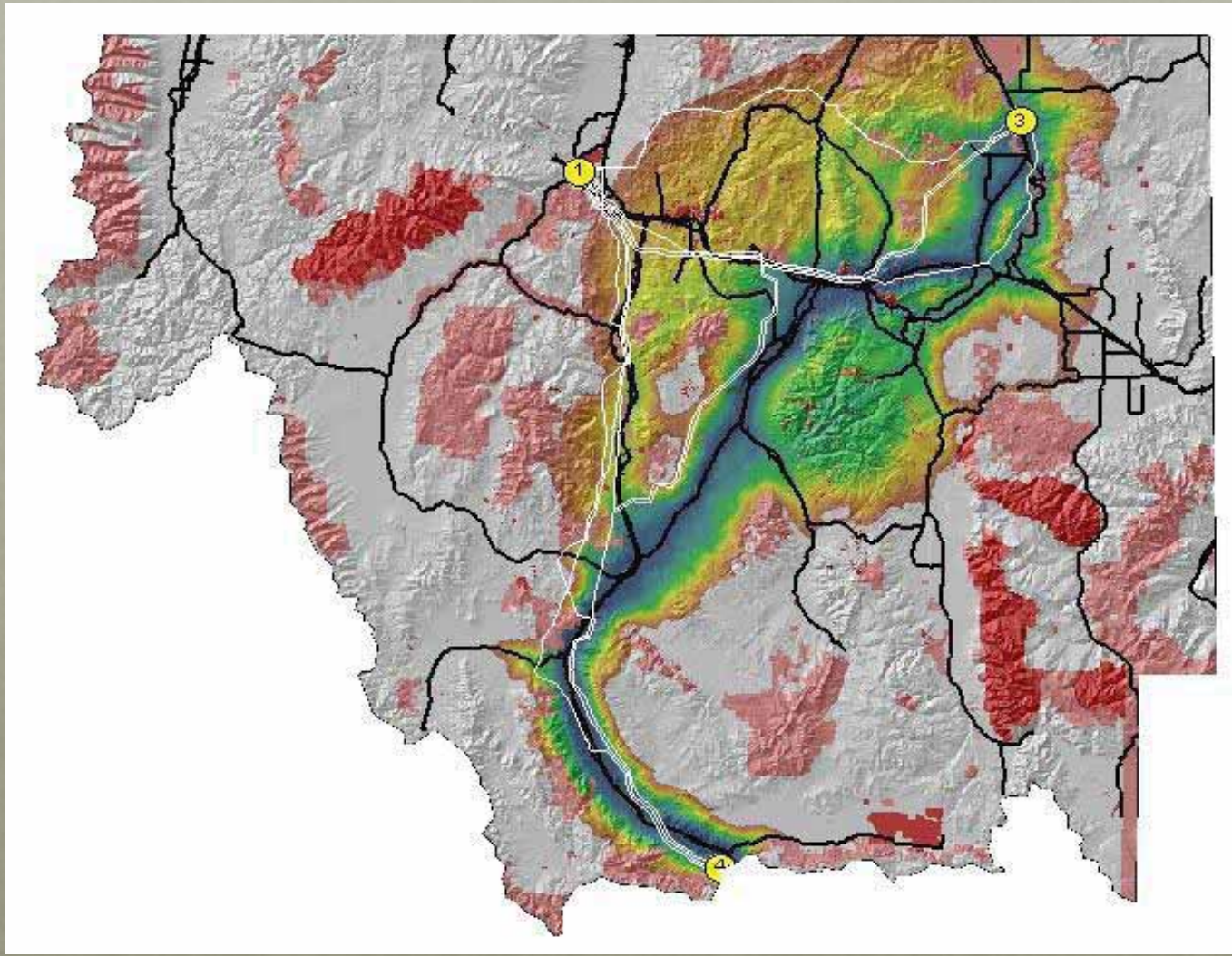
Decision Support Tool: Wildlife

- Avoids most vulnerable habitats
- Avoids habitat fragmentation
- Increases costs through habitats with species of concern
- Increases costs through secure habitats
- Decreases costs through habitats already modified by infrastructure

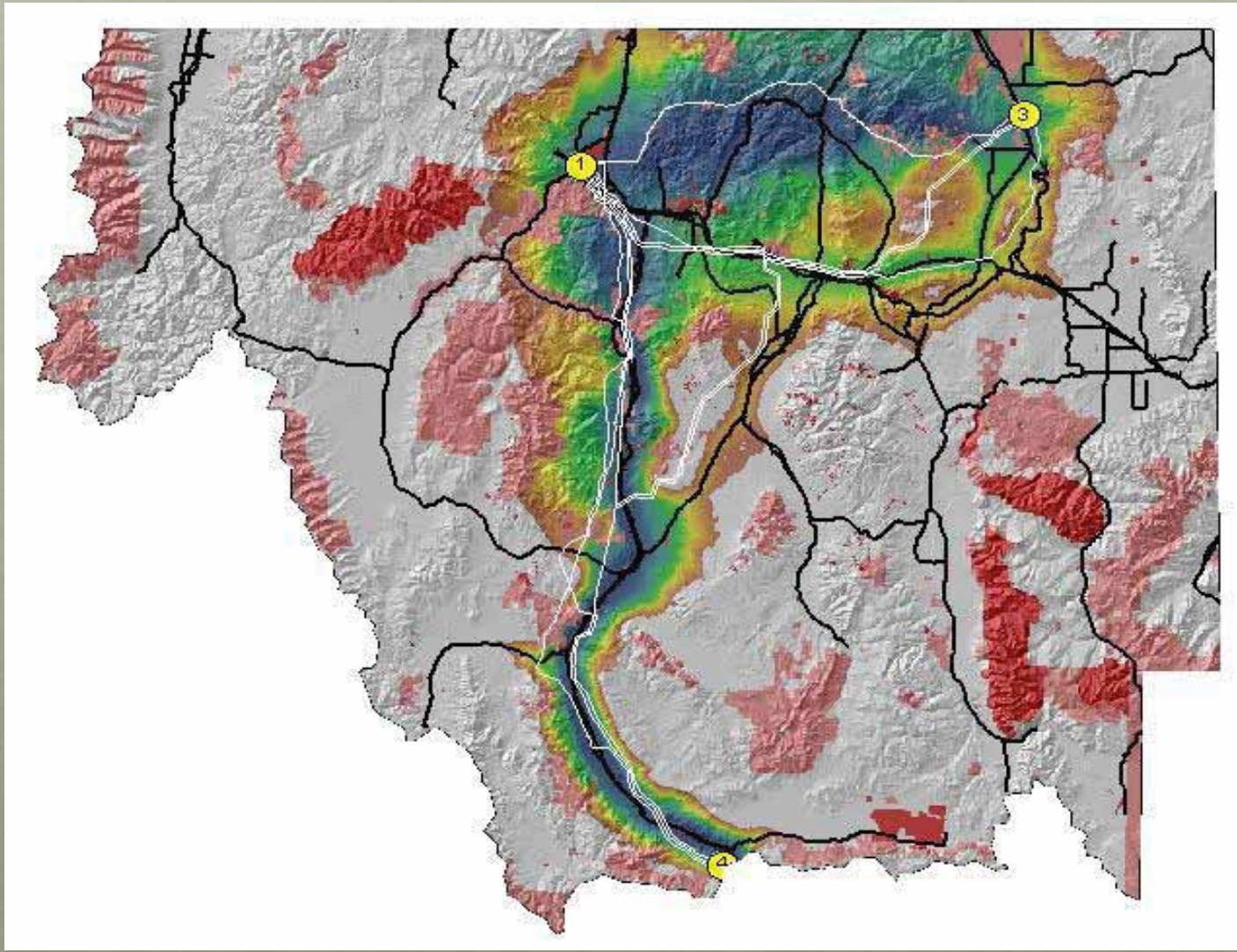
WILDLIFE COST SURFACE



WILDLIFE TOWNSEND TO IDAHO BEST 10%



WILDLIFE TOWNSEND TO MILL CREEK TO IDAHO BEST 10%



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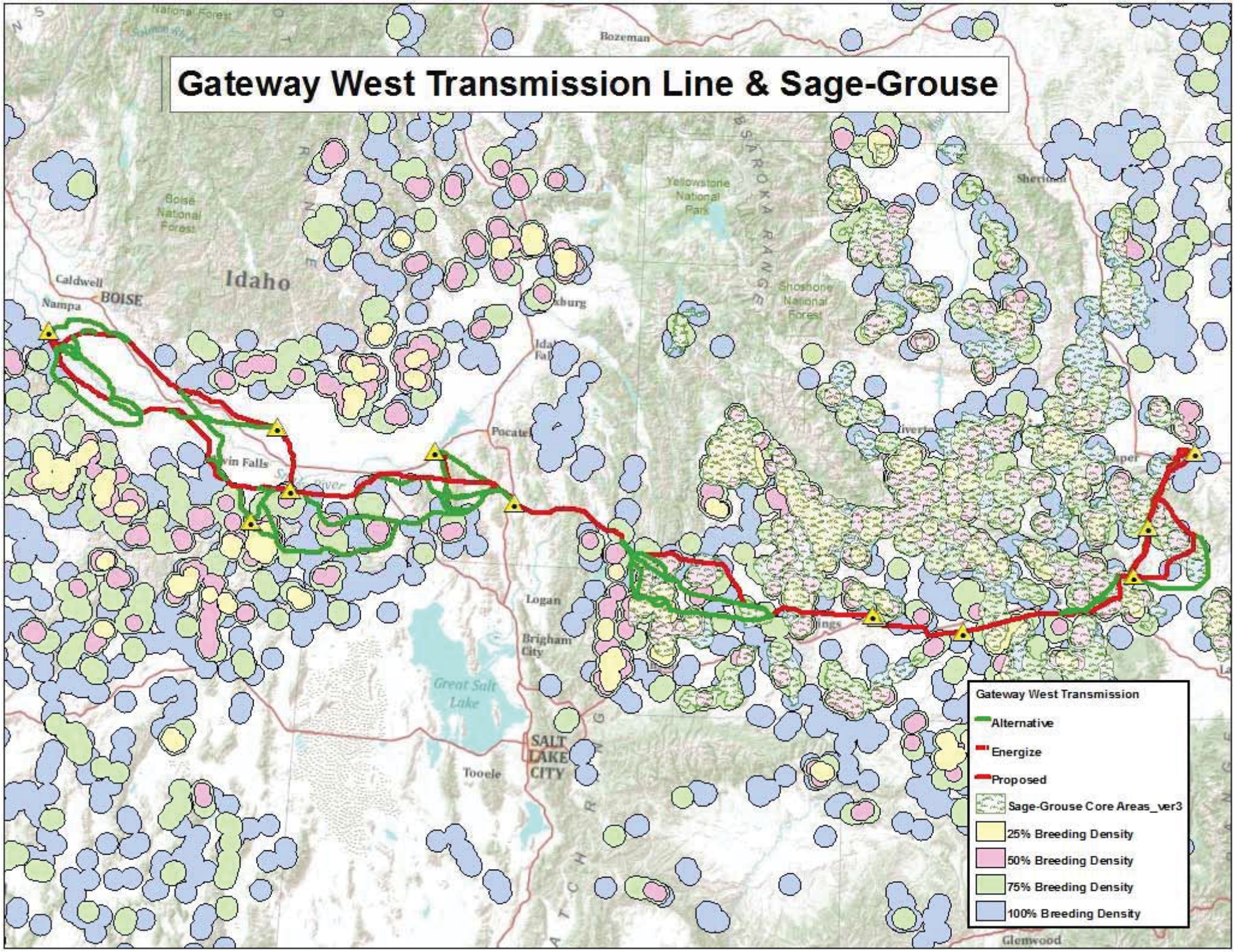
  - 406-587-7331; cellis@sonoraninstitute.org
- Stakeholder Outreach: Dennis Glick, Future West
  - 406-587-2974; dennis@future-west.org

Gateway West Transmission Line & Sage-Grouse



Endangered Species

Mountain-Prairie Region

GREATER SAGE-GROUSE

The greater sage-grouse is a large, rounded-winged, ground-dwelling bird, up to 30 inches long and two feet tall, weighing from two to seven pounds. It has a long, pointed tail with legs feathered to the base of the toes. Females are a mottled brown, black, and white. Males are larger and have a large white ruff around their neck and bright yellow air sacks on their breasts, which they inflate during their mating display. The birds are found at elevations ranging from 4,000 to over 9,000 feet and are highly dependent on sagebrush for cover and food.

Currently, greater sage-grouse are found in Washington, Oregon, Idaho, Montana, North Dakota, eastern California, Nevada, Utah, western Colorado, South Dakota and Wyoming and the Canadian provinces of Alberta and Saskatchewan and occupy approximately 56 percent of their historical range.

After a thorough analysis of the best available scientific information, the Fish and Wildlife Service has concluded that the greater sage-grouse warrants protection under the Endangered Species Act. However, the Service has determined that proposing the species for protection is precluded by the need to take action on other species facing more immediate and severe extinction threats.

As a result, the greater sage-grouse will be placed on the list of species that are candidates for Endangered Species Act Protection. The Service will review the status of the species annually, as it does with all candidate species, and will propose the species for protection when funding and workload priorities for other listing actions allow.

Evidence suggests that habitat fragmentation and destruction across much of the species' range has contributed to significant population declines over the past century. If current trends persist, many local populations may disappear in the next several decades, with the remaining fragmented population vulnerable to extinction.

However, the sage-grouse population as a whole remains large enough and is distributed across such a large portion of the western United States that the needs of other species facing more immediate and severe threat of extinction must take priority.

See factsheet

Also included in this finding are two additional and related actions: (1) whether there is a western subspecies of greater sage-grouse; and (2) if the sage-grouse populations in the Bi-State area of California and Nevada quality as Distinct Population Segments (DPS) and if they warrant listing.

For more information:

- Federal Register Notice March 5, 2010: 12-Month Findings for Petitions to List the Greater Sage- Grouse (Centrocercus urophasianus) as Threatened or Endangered
- News Release March 5, 2010: Interior Expands Common-Sense Initiative to Conserve *Sage Grouse* Habitat in the West
- News Release March 5, 2010: Fish and Wildlife Service to Add Bi-State DPS of Greater Sage-Grouse to Candidate List
- News Release March 5, 2010: U.S. Fish and Wildlife Service Says Western Sage-Grouse Not a Sub-species
- Factsheet Regarding the Status Review Finding
- Questions and Answers Regarding the Status Review
- Powerpoint Presentation (Science and Research) This presentation is intended to provide basic public information about the U.S. Fish and Wildlife Service's 12-month finding for the greater sage-grouse, conducted pursuant to the Endangered Species Act. It is not a comprehensive treatment of the finding or an exhaustive analysis of the species' status. Please refer to the actual published finding for the complete body of work and information related to the status of the species throughout its range.
- *Studies in Avian Biology*. Preparation was jointly led by USGS scientist Steven Knick and Idaho Fish and Game scientist John Connelly.

Video clips of male breeding behavior

- Video (b-roll)
- Longer video - Greater Sage Grouse
- Short video - Greater Sage Grouse

Archives

More information can be found at the Service's ECOS webpage

Last updated: May 25, 2011

Briefing Paper

Prairie Grouse Leks and Wind Turbines: U.S. Fish and Wildlife Service Justification for a 5-Mile Buffer from Leks; Additional Grassland Songbird Recommendations

Date: July 30, 2004 [Prairie Grouse Lek 5 Mile Public.doc]

Issue: The U.S. Fish and Wildlife Service (FWS, Service, or we) recommended "... avoiding placing wind turbines within 5 miles [8 km] of known leks (communal pair formation grounds[a]) in known prairie grouse habitat" (see p. 4, item 7, Site Development Recommendations) in our *Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines*, a notice of its availability published July 10, 2003 in the *Federal Register*. Some have questioned the validity of this recommendation, specifically the distance metric. While many grouse biologists consider 3 distinct groups of grouse in North America, including forest grouse (*e.g.*, Ruffed, Blue, and Spruce), prairie grouse (*e.g.*, Greater and Lesser Prairie-chickens and Sharp-tailed Grouse), and Sage-grouse (F. Hall 2004 personal communication [hereafter pers. comm.]), the Service's guidance included prairie and sage grouse within the same general "prairie grouse" category. This briefing paper provides justification for the Service's recommendation for a 5-mile buffer from occupied prairie grouse leks.

The Service reiterates that our wind siting guidelines are voluntary; we are not restricting installation of wind turbines or wind facilities within a 5-mile radius of active leks. Prior to any site selection, we recommend that the wind consultant/company/contractor assess the complete habitat requirements and habitat use and needs of whatever species of prairie and sage grouse is involved (*e.g.,* Greater and Lesser Prairie-chickens, and Gunnison and Greater Sage-grouse, and Columbia Sharp-tailed Grouse) at the site. All habitat requirements of prairie grouse should be considered, *i.e.*, habitats for courting and breeding (leks), nesting, brooding, resting, feeding, migrating, and wintering. Given continuing uncertainties about structural impacts on prairie grouse, especially the lack of data regarding impacts from wind facilities, and the clearly declining trends in prairie grouse populations (see below), we urge a precautionary approach by industry and recommend a 5-mile buffer where feasible. The public comment period on our voluntary guidance will continue to be open through July 10, 2005. We strongly encourage all interested parties to provide suggestions and recommendations on our voluntary guidance that will help improve its reliability and update its usability. Comments on the distance metric, especially those derived from ongoing scientific studies, will be important.

It also was recommended that we include a brief discussion on the declining populations of grassland and sage-steppe obligate songbirds and the need to protect their habitats. This briefing statement will review their habitat needs and will briefly discuss disturbance and habitat fragmentation.

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[a] Leks are technically not "communal pair formation grounds." Sage-grouse, for example, are not "pair forming" on leks and only a few males complete most of the breeding (F. Hall 2004 pers. comm.). Leks may best be described as traditional display areas normally located on very open sites in or immediately adjacent to breeding (nesting and early brood-rearing) habitats (J. Connelly 2004 pers. comm.).

Prairie Grouse Status:

All species of prairie grouse are declining, some severely. The range and population of the Lesser Prairie-chicken (LPCH) have declined > 90% since European settlement of the great plains 100 years ago (Giesen 1998). The Attwater's Greater Prairie-chicken has been Federally listed as endangered in its entire range -- now Texas -- since 1967. The LPCH is currently listed as a candidate species under ESA in CO, KS, NM, OK, and TX. A "candidate species" is a plant or animal for which FWS has sufficient information on their biological status and threats to propose listing under ESA, but for which development of a listing regulation is precluded by other higher priority listing activities. It is a formal ESA designation, although candidate species do not receive legal protections under the Act.

The Gunnison Sage-grouse, found in the Gunnison Basin (CO and UT) was candidate-designated under ESA in 2000. Their listing priority has recently been elevated. Populations of the Greater Sage-grouse have declined 66-92% during the past 30 years in western Canada where they are listed as endangered (Aldridge and Brigham 2002). Throughout North America, Sage-grouse distribution has been reduced by at least 50% since the early 1900s, with extirpation in 5 of 16 States and 1 of 3 Canadian Provinces. Breeding populations of Sage-grouse have declined 45-80% from numbers estimated in the 1950s (Connelly and Braun 1997, Braun 1998, Connelly *et al.* 2004). The Greater Sage-grouse in the Columbia Basin (WA and OR) was also designated as a candidate species. In April 2004, FWS published a 90-day finding in the *Federal Register* (69 FR 21484) with regard to range-wide listing petitions for the Greater Sage-grouse. The FWS found that the petitions and additional information available in our files present substantial information indicating that listing may be warranted. This positive 90-day finding triggered a FWS status review of the species which will result in a 12-month finding that is to be available in December 2004 (K. Kritz 2004 pers. comm.). In June 2004, the Western Association of Fish and Wildlife Agencies published a comprehensive, science-based assessment of the Greater Sage-grouse and its habitat, reviewing landscape information for the past 100 years, population data for the past 60 years, and the available literature (Connelly *et al.* 2004; see beyond).

While wind turbines and wind facilities are new additions to prairie grouse habitats in the Midwest and West, their impacts to grouse populations could add to the cumulative effects of human development and exploitation from other sources in grouse and songbird habitats. With these continuing uncertainties, we recommend that the industry take a cautious approach. Prairie grouse did not evolve with tall vertical structures present so the addition of wind turbines and their supporting infrastructure represents a significant change in the species' environment (J. Connelly 2004 pers. comm.). Given the declining or precarious status of grouse populations, the impacts of wind development on prairie grouse must be evaluated with great care and considerable detail. Prairie grouse are "indicator organisms," showing us the health of their environments, and sage grouse are "sensitive keystone species," representing critical components of their habitats (Lyon and

Anderson 2003, S. Harmon 2004 pers. comm.). Grassland and sage-steppe-obligate songbirds (*e.g.*, Sage Sparrow, Brewer's Sparrow, Sage Thrasher, and Black-chinned Sparrow) are also showing serious population declines. Grassland songbirds are the fastest declining suite of birds in North America (Johnson *et al.* 2004).

Justification for Our Distance Recommendation:

While we acknowledge that much research continues on prairie grouse and the impacts of tall structures, including wind turbines – and thus much of the data have yet to be peer reviewed and published – several studies and their recommendations have been published and are used as the basis for our 5-mile recommendation. Most compelling was the recommendation by Connelly *et al.* (2000:978) calling for protection of breeding habitats within 11.2 mi (18 km) of the leks of migratory populations of Sage-grouse (see discussion beyond). See also Giesen and Connelly (1993) beyond for a discussion of management guidelines for Columbian Sharp-tailed grouse.

Extensive personal communications with many grouse specialists were also important in helping us make our determination. The published reviews (some of which were in press at the time of our recommendation) are included below.

We believe it is important to clarify that avoidance of vertical structures by grassland and sage-steppe-obligate wildlife is not a new issue, and the Service's recommendations are not merely reactive to current recommendations promoting wind power development nationwide. Concerns were brought to the Division of Migratory Bird Management as early as 2000 regarding the possible impacts of wind turbines on prairie grouse, including noise, habitat disruption, disturbance, fragmentation, and increased predator access (R. Reynolds and N. Niemuth, FWS Habitat and Population Evaluation Team, Bismark, ND 2000 pers. comm.). Much research has also been conducted on the impacts of high tension power transmission and electric distribution lines on prairie grouse, providing a detailed body of literature on a related structural issue (*e.g.*, Connelly *et al.* 2000, Braun *et al.* 2002, Hagen 2003, Wolfe *et al.* 2003a and 2003b, Pitman 2003, Hagen *et al.* 2004, Patten *et al.* 2004, and Connelly *et al.* 2004).

Lesser Prairie-Chicken

Mote *et al.* (1998:18) reported the findings of the Lesser Prairie-Chicken Interstate Working Group (represented by CO Division of Wildlife, KS Department of Wildlife and Parks, NM Department of Game & Fish, OK Department of Wildlife Conservation, and TX Department of Parks & Wildlife). This State-led team of species experts, with input and review by researchers and academics, identified the need for a contiguous block of 20 mi^2 (52 km^2) of high quality rangeland habitat to successfully maintain a local population of LPCH. If this area represented a hypothetical square home range (Figure 1), its boundaries would be approximately 4.5 x 4.5 mi (7.2 km) and a lek located in its center would be 2.25 mi (3.6 km) from the nearest side. If the hypothetical contiguous block were a circle (Figure 2), its radius would be 2.5 mi (4.1 km) in length from a lek

located in its center. In Figure 2, we incorporated an additional 1.25-mi (2 km) minimum protection buffer zone beyond this hypothetical home range as recommended by Hagen *et al.* (2004:79), discussed below. Because range wide, the majority of remaining LPCH populations are fragmented and isolated into "islands" of unfragmented, open prairie, thus we assert that a 5-mile buffer from a lek is recommended to protect the wind power industry from later determinations that construction activities could significantly impact important LPCH populations and habitat corridors needed for future recovery.

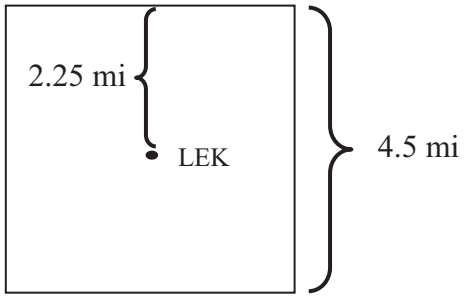

Fig 1. 20 mi^2 protected habitat.

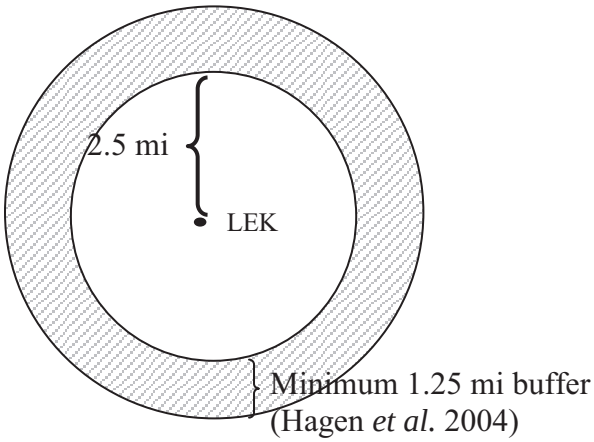

Fig 2. 20 mi^2 protected habitat using 2.5 mi radius from lek; with additional buffer zone recommended by Hagen *et al.* (2004), protected area = 44.2 mi^2.

Figures 1 and 2 illustrate the minimum scale of unfragmented habitat necessary to maintain a LPCH local population (S. Harmon 2004 pers. comm., B. Obermeyer 2004 pers. comm., after Mote *et al.* 1998:18).

Other individual studies however, discussed in the next several paragraphs, have suggested recommendations for protected distances less than those presented by Mote *et al.* (1998). These variations may reflect differences between individual populations, the variability in the complexity of different habitats, habitat fragmentation and disturbance, and other unknowns. For example, Pitman (2003:45, 49) and J. Pitman (2004 pers. comm.) noted that > 80% of LPCH hens nested closer to a lek other than their lek of capture and they moved on average > 1.9 mi (3 km) from their capture location to initiate a nest. He indicated that the presence of buildings, improved roads, power lines, agricultural edge, and oil and gas wellheads all eliminated potential nesting habitat for a radius of up to 0.62 mi (1 km; p. 46). Roads, power lines and sometimes agricultural edge are all anthropogenic features associated with wind energy facilities. He suggested that in order to maintain movement between sub-populations of LPCH, habitat fragments should not be further than 6.2 mi (10 km; p. 142) apart. The recommendation was based on the dispersal distance of juvenile females although the sample size was very small.

As a further example, Hagen (2003:156, 177) and C. Hagen (2004 pers. comm.) studied LPCH in southwestern KS. He concluded that landscape features, the proportion of an area occupied by power lines, and the proximity of human structures clearly reduced

otherwise suitable habitat. The mean distance chickens avoided structures was 0.9 mi (1.4 km; p. 162). However, Hagen (2004 pers. comm.) cautioned that data are presently lacking that indicate what happens to LPCH as habitat patches become smaller or as patch quality becomes less diverse and as anthropogenic features become more abundant. The distances in his study may reflect the "tolerance" level of LPCH to structures in fragments of < 12,350 ac (5,000 ha) in size of moderate quality. He recommended that as patch size becomes smaller and/or of lower quality, the LPCH will be less tolerant to disturbance and fragmentation. Until data can support an alternate hypothesis, Hagen (2003:159) and C. Hagen (2004 pers. comm.) suggested protecting as large a buffer around remaining habitat as possible.

Hagen *et al.* (2004:79), in "guidelines for managing lesser prairie-chicken populations and their habitats," recommended that wind turbines and other tall vertical structures be constructed >1.25 mi (2 km) from known or potentially occupied LPCH habitat, at a minimum. This recommended area represents a buffer beyond already existing LPCH home ranges (Figure 2). If wind facilities must be placed in known LPCH habitats, Hagen *et al.* (2004) suggested they be positioned along prairie edge or clustered in sites with other disturbances.

Wolfe *et al.* (2003a:18) assessed LPCH habitat use and avian impacts in OK and NM. They indicated that while a common suggestion is to manage for nesting habitat within 1 mile (1.6 km) of a gobbling ground (lek), much larger areas are more likely to sustain broods. On average, hens nested 2.3 miles (3.7 km) from the lek on which they were captured (the record distance was 13.7 mi [21.9 km], p. 9), while successful nests averaged 2.6 miles (4.2 km) from the lek upon which the hen was captured. Their research also suggested that fragmentation from roads, fences, and power lines are a greater mortality factor than what had previously been thought. Collisions with human-built structures may be additive to other mortality. Wolfe *et al.* (2003b) reported that fragmentation likely elevated LPCH mortality due to collisions with fences and power lines. Wolfe *et al.* (2003a:16 and 2003b) noted that scavenging, especially by mammals, can occur at > 50% of the carcasses within days, resulting in collision rates that are likely higher than they had reported. Wolfe *et al.* (2003b) and Patten *et al.* (2004a:1) reported that females in both NM and OK suffered greater mortality from collisions with human-built structures than did males. Females were reported less susceptible to predation in both NM and OK, but more susceptible to collisions with fences, power lines, and vehicles (Patten *et al.* 2004a:9; 0.29 for female mortality due to predation vs. 0.48 for female mortality due to collisions, N=79 females, based on the Kendall's τ correlation matrix).

Patten *et al*. (2004a:12-13) noted that female LPCHs tend to breed only during a single year in OK, making the OK population more susceptible to annual environmental stochasticity (randomness) and a higher probability of going extinct within the near future. In NM, breeding was more likely to also occur in the 2nd and 3rd years. Habitat fragmentation, based on evidence from their study, can markedly affect the likelihood of population persistence and survival (p. 14). Patten *et al*. (2004a:28) modeled the

probability of extirpation of LPCH in OK over the next 30 years. A few “bad years,” they concluded (*i.e.,* climatic changes resulting in unfavorable weather conditions, low food yields, and heavy predation) could put the species over the brink, giving conservation professionals little time to react. This “too little, too late” scenario occurred with the Attwater’s Prairie-chicken, largely due to the unavailability of necessary habitat that prairie grouse require (S. Harmon 2004 pers. comm.).

For LPHCs, increased habitat fragmentation and isolation of existing populations are of major concern. The placement of wind plants in a critical corridor area between 2 or more populations might permanently prevent connectivity. Potential connectivity corridors, however, have not been fully identified (D. Wolfe 2004 pers. comm.).

Greater Prairie-Chicken

Although many studies have identified prairie grouse avoidance of vertical structures, to date, the only documented case of interaction specifically between prairie grouse and a commercial wind facility comes from northwestern MN. This information, however, is anecdotal in nature, collected peripheral to other research. As a result, no peer review or statistical testing of the findings are possible at this time. Society and Toepfer (2003:47) reported in their study area, composed of a habitat patch approximately 3 x 4 mi (4.8 x 6.4 km), that some individual Greater Prairie-chickens (GPCH) appeared to tolerate to some degree a small complex of 3 wind turbines. Specifically, researchers documented 6 active leks within 2 mi (3.2 km) of the 3 wind turbines, 1 lek within 0.6 mi (1 km) of the nearest turbine, and 1 hen with a brood immediately adjacent to a turbine. However, Society and Toepfer (2003:47) cautioned that further development and expansion of wind power on this site could negatively impact the use of the grassland by Chickens.

When considering this case, the Service contacted the primary investigator and discussed the observations at length. For the following 3 reasons, we find that Society and Toepfer's (2003) observations may not necessarily be in conflict with other researchers' findings and our voluntary siting guidelines. First, it is important to emphasize that this study site is relatively small and isolated within a landscape of primarily cultivated fields. As a result, individual GPCHs in the local population have little alternative than to continue using the habitat, regardless of its level of fragmentation.

Second, the documentation of active leks within 5 miles of the turbines may reinforce what is widely known about the behavior and life history of male Prairie Grouse. Within these species, females are the primary dispersers, whereas males "imprint" on a particular lek and nearby leks, and remain in the vicinity until their death. For this reason, males are very unlikely to leave historic leks, regardless of habitat quality or disturbance. Unless a particular human activity results in direct adult mortality, local lek counts may not decline for many years following a particular fragmentation event. An often-cited example of this behavior involves Greater Sage-grouse cocks observed strutting on the busy airport runway in Jackson Hole, WY. The runway was constructed over an historic

lek, yet cocks continued to display on the site for many years because there is little alternative habitat in the small, isolated valley (P. Deibert 2004, pers. comm.).

Third, the population of GPCHs inhabiting this particular study site is considered very robust compared to other studies of Prairie Grouse. Lek counts in the small study area are known to be as high as 40 birds/lek. Given the small habitat scale and high density of both leks and birds per unit area, it is clear that amount of habitat, and not necessarily survivability, is a primary limiting factor constraining this population. Consequently, birds within this population are likely to be observed in all portions of useable space, and anecdotal sitings near the wind turbines neither confirm nor deny prairie grouse tolerance of commercial wind facilities in more typical habitats. However, these sitings offer the possibility that prairie grouse may be more tolerant of wind turbines than current research data suggest (S. Harmon 2004 pers. comm., B. Obermeyer 2004 pers. comm.). The preliminary findings also imply that, if other factors are not limiting to GPCHs, turbines might not be avoided elsewhere. However, while birds may persist near turbines, survival of those individuals may be compromised, resulting in a population decline. Until more studies are conducted, we can only speculate about cause-and-effect and survivorship (B. Millsap 2004 pers. comm.).

Because Prairie Grouse are relatively long-lived birds (often 3-6 years), and because they exhibit high site fidelity and clumped distribution on the landscape, the Service cautions that anecdotal sitings of individuals near wind turbines are neither unexpected nor informative about the cumulative effects of structural avoidance and habitat fragmentation on populations as a whole. Comprehensive, long-term studies in unconstrained habitats are essential to determining what level of habitat avoidance can be expected in response to wind turbine construction in occupied Prairie Grouse range (S. Harmon 2004 pers. comm.).

Patten *et al.* (2004b:1-2, 32) examined habitat fragmentation and its impacts on GPCH. Because of virtually no habitat fragmentation and a high continuity of tallgrass prairie in their study area, their estimate of home range size was determined to be the smallest of any study for this species. The minimum habitat size needed to avoid impacts to GPCHs in their study area was estimated at about 38.5 mi^2 (99.7 km^2). If the hypothetical contiguous block were a circle (Figure 4), its radius would be 3.5 mi (5.6 km) in length from a lek located in its center. When we incorporated an additional minimum 1.25-mi (2 km) protection zone recommended by Hagen *et al* (2004:79), the area of the larger circular home range is 70.9 mi^2 (184.3 km^2). If this area represented a hypothetical square home range (Figure 3), its boundaries would be approximately 6.2 x 6.2 mi (10 km) and a lek located in its center would be 3.1 mi (5 km) from the nearest side.

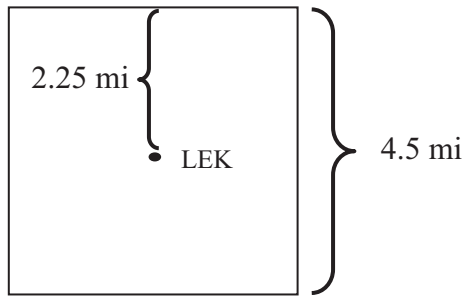

Fig 3. 20 mi^2 home range.

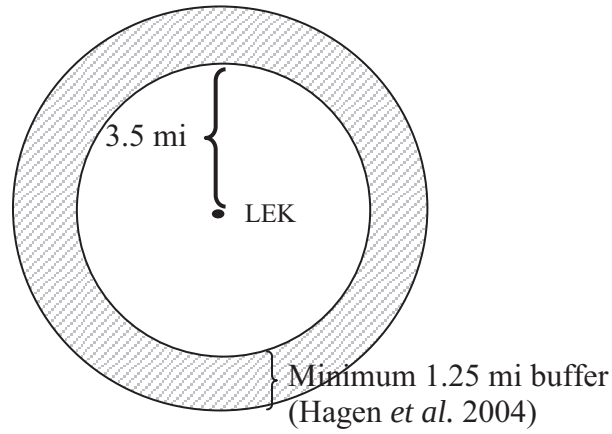

Fig 4. 38.5 mi^2 protected habitat using 3.5 mi radius from lek; with additional buffer zone recommended by Hagen *et al.* (2004), protected area = 70.9 mi^2.

Figures 3 and 4 show the minimum area of un-fragmented habitat necessary to maintain a local population of GPCH (S. Harmon 2004 pers. comm., B. Obermeyer 2004 pers. comm., after Patten *et al.* 2004b:1-2,32).

Results of the Patten *et al.* (2004b:2, 32) study predict that increased habitat fragmentation will force individual GPCHs to expand their home range, resulting in a decrease in survivorship from more predation, collisions, and energy expenditures.

age gr e

Connelly *et al.* (2000) recently revised and expanded the guidelines for the management of Sage-grouse, originally published by Braun *et al.* (1977). Based on seasonal movements among populations, Connelly *et al.* (2000:969) summarized the 3 types of Sage-grouse populations: 1) those which are non-migratory and do not make long-distance movements (*i.e.* > 6 mi [10 km] one-way), 2) those which exhibit one-stage migration between 2 distinct seasonal ranges, and 3) those which exhibit 2-stage migration among 3 distinct seasonal ranges. Connelly *et al.* (2000:969) further reported that migratory Sage-grouse can occupy areas in excess of 1,042 mi^2 (2,700 km^2). Connelly *et al.* (2000:977-978) developed recommendations for habitat protection upon which, in part, the Service's guidance is based. Specifically, for non-migratory populations occupying habitats that are uniformly distributed, they recommended protecting sagebrush and herbaceous understory within 2 mi (3.2 km) of all occupied leks. For non-migratory populations, leks should be considered the center of year-round activity and treated as the focal points for management activities. For non-migratory populations where sagebrush is not uniformly distributed, suitable habitats should all be protected out to 3.1 mi (5 km) from all occupied leks. For migratory populations of Sage Grouse, breeding habitats within 11.2 mi (18 km) of active leks should be protected, recognizing that nesting birds may move > 11.2 mi (18 km) from leks to nest sites. This recommendation (Figures 5 and 6) obviously represents a protected area much larger than the 5-mile suggestion by the Service. While Connelly *et al.* (2000) made a distinction between resident and migratory (2 types) populations, in radio telemetry research

conducted by Hall in Lassen County, CA, from 1998-2001 (F. Hall 2004 pers. comm.), his team discovered that some Sage-grouse populations include both resident and migratory birds down to the individual lek level. Specifically, they found resident, 1-stage and 2-stage females present on each of 9 leks (unpublished data). Populations are not always either resident or migratory.

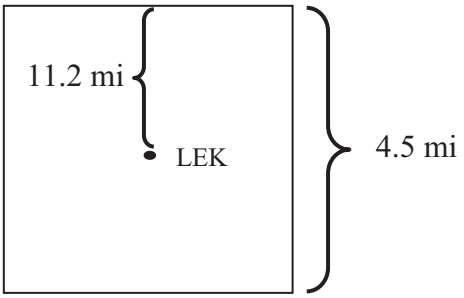

Fig 5. 502 mi^2 home range.

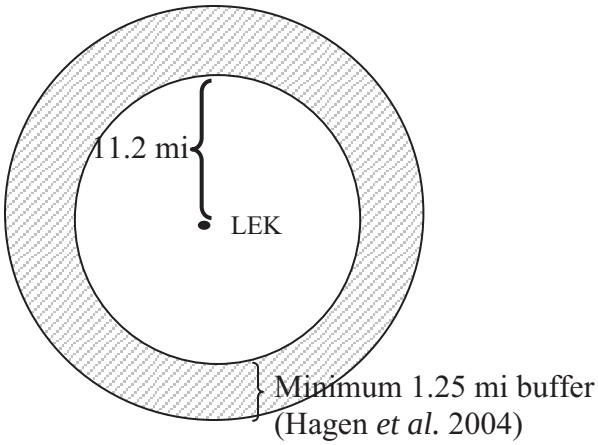

Fig 6. 394 mi^2 protected habitat using 11.2 mi radius from lek; with additional buffer zone recommended by Hagen *et al.* (2004), protected area = 486.95 mi^2.

Figures 5 and 6 illustrate the recommended protected breeding habitat for migratory populations of Sage-grouse based on a hypothetical square and circular home range, after Connelly *et al.* (2000:978) with buffer suggested by Hagen *et al.* (2004:79).

C. Braun (2004 pers. comm.) provided further comment on the recommendations discussed by Connelly *et al.* (2000:978) above (he was a coauthor of this article). For non-migratory populations of Sage-grouse, he felt a distance of 2 mi (3.2 km) was sufficient to protect breeding habitat from leks where no habitat disturbance was present. Where habitat disturbances were noted, he recommended a 3-mile (5 km) no-disturbance zone. For migratory populations, he reiterated Connelly *et al*'s 11-mile (18 km) no-disturbance zone from active leks. These recommendations he felt were based on "best professional judgment" and should change only when "no impacts could be demonstrated" by industry for zones of disturbance of lesser distance from leks. Wind generators, he indicated, were quite tall and could be seen and avoided by Sage-grouse for long distances. Noise (especially humming), motion, and height all may negatively affect Sage-grouse, although he indicated we still don't know the specific effects. Braun therefore felt that FWS could defend our 5-mile recommendation even though definitive data showing impacts are still being collected. C. Aldridge (2004 pers. comm.) also felt the Service's 5-mile distance recommendation "was reasonable" and represented an adaptive management approach by the FWS. He indicated that it was in "everybody's best interest to err on the safe side" especially due to issues regarding avoidance

(including known and unknown impacts), landscape effects of wind and other structures, and the simple occurrence of birds versus their overall survival.

For the biologists who have worked on Sage-grouse for some time, it was noted that birds seem to be especially susceptible to disturbance and will often abandon nests even in later stages of incubation. Certainly wind turbine construction and maintenance activities fall under the category of "disturbance" (J. Connelly 2004 pers. comm.).

Connelly *et al.* (2004) published the most comprehensive, science-based synthesis of the Greater Sage-grouse and its habitat needs yet conducted. While the Conservation Assessment did not provide minimum distance recommendations from wind turbines, it did discuss wind energy development as one of several factors that could impact sagebrush ecosystems and thereby Sage-grouse. Noise from wind turbine rotor blades and bird mortality were cited as issues of concern regarding wind energy (Chap. 7:42-43). Connelly *et al.* (2004) were not optimistic about the future of Sage-grouse because of long-term population declines coupled with loss and degradation of habitat and other factors such as disease (ES:5). They also raised concerns about the distribution, configuration, and characteristics of Grouse migration corridors which unfortunately are largely unknown in most portions of the Sage-grouse range (Chap. 4:19). Disturbance issues were also discussed regarding lek distribution and highways (Chap. 13:12-13. Lyon and Anderson (2003) further documented effects of disturbance on breeding Sage-grouse.

Braun *et al.* (2002:345, 346) reported that the sagebrush-obligate species, Gunnison and Greater Sage-grouse, were particularly susceptible to noise near leks and to the placement of overhead power lines at least 0.5 mi (0.8 km) from any Greater Sage-grouse breeding and nesting grounds. Development was viewed as a negative impact in this study, characterized by a loss of habitat and disturbances associated with structures, roads, and noise – especially during the breeding season.

F. Hall (2004 pers. comm.) in a Lassen County, CA study on Greater Sage-grouse has recently documented significant impacts from overhead power transmission and communication distribution lines to this species out to 3.7 mi (6 km). When these lines are placed near turbines, they could provide perches for Golden Eagles and nest sites for Common Ravens. This concern coincides with the Service's recommendation (see Turbine Design and Operation, no. 4, p. 4) to place electric power lines underground or on the surface as insulated, shielded wire to minimize strike and electrocution problems.

In a related study, Popham and Gutierrez (2003:331, 332) radio-tagged 65 female Greater Sage-grouse in northern CA of which 45 radio-tagged hens were tracked to their nests. Successful grouse nests were located farther from the nearest lek (2.2 mi [3.6 km], SE= 811 m) than were nests that were unsuccessful (1.2 mi [1.96 km], SE=384 m; p. 331). Others, however, have not noticed this difference (J. Connelly 2004 pers. comm.). Popham and Gutierrez noted that native shrub-steppe habitat had been degraded due to excessive grazing, juniper encroachment, agriculture, and anthropogenic development.

Results from the Popham and Gutierrez study represent a portion of the entire ongoing project being conducted by Hall and his team in Lassen County, CA (F. Hall 2004 pers. comm.).

Johnsgard (2002:116) indicated that there was no obvious relationship between lek location and nest site. In 5 different studies involving more than 300 nests the average distance between lek and Sage-grouse nest where the females was first seen or captured was 3.5 mi (5.6 km). This distance is greater than the mean interlek distance from several studies, which ranged from 0.8- 3 mi (1.3- 4.8 km; Wakkinen *et al.* 1992, Johnsgard 2002:116, J. Connelly 2004 pers. comm., R. Hazlewood 2004 pers. comm.).

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Disturbance to Sharp-tailed Grouse was reported by Baydack and Hein (1987:538) in southwestern Manitoba. While males were reported present during disturbances (*e.g.*, parked vehicles, propane exploders, scarecrows, taped voices, radio sounds, and a leashed dog), female Sharptails were not observed on leks during test disturbances. Disturbance appeared to limit reproductive opportunities for both sexes. They concluded that continued disturbance over several seasons could bring about population declines.

Giesen and Connelly (1993) reported on movements and management needs of Columbia Sharp-tailed Grouse in the West. While wind turbines were unavailable to assess during this time frame, reported Grouse movements between breeding areas and winter range – varying from 1.6 mi (2.6 km) to 12.4 mi (20 km) depending on study and location (p. 327) – could be impacted by current and proposed wind development. They specifically indicated the lack of experimental data on the effects of habitat alterations on this species. Among their recommendations, Giesen and Connelly (1993:331) suggested avoiding vegetation manipulation within a 1.25-mi (2 km) radius of the active lek in order to protect the nesting and brood-rearing habitats of this Sharp-tailed Grouse.

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During periods of population decline, prairie grouse may abandon lekking sites in smaller, fragmented habitats and congregate into larger, more intact areas (core habitat). Given that many grouse species are currently at population lows, human development of suitable but abandoned prairie grouse habitat could severely impede efforts to restore their numbers. In other words, protection of core prairie grouse habitat through the use of the Service's 5-mile buffer is a conservative approach (B. Obermeyer 2004 pers. comm.).

Obermeyer and Applegate (unpublished data) located 31 active GPCH leks in a 181-mi^2 area (465 km^2, 115,000 acres) of native rangeland in eastern Greenwood County, KS, during spring of 1997. Lek influence within the study area, as defined by a 1.9-mi (3-km) radius, was 152.6 mi^2 (391.4 km^2; Figure 7). Generally, the stronger leks were located in the more unfragmented areas of native rangeland. A much larger zone of lek influence at this study area was noted just a few years previous. Lek distribution along the western boundary shrank by approximately 6 miles between 1987 and 1997 (B. Obermeyer 2004 pers. comm.). Development of suitable but abandoned prairie grouse habitat (*e.g.*, unoccupied, historical leks) could seriously impede prairie grouse restoration efforts.

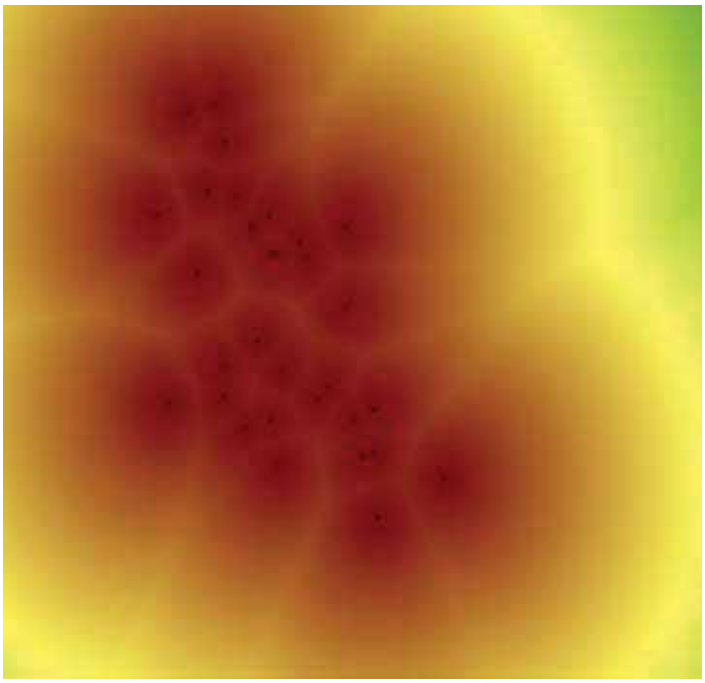

Figure 7. Dots represent 1997 locations of GPCH leks within a 115,000-acre block of tallgrass prairie in KS. Yellow area = ~237 mi^2 (608 km^2; unpubl. data).

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Manes *et al.* (2004 manuscript in preparation, R. Manes, S. Harmon, B. Obermeyer, and R. Applegate 2004 pers. comm.) summarized the documented effects of wind facilities on birds, indicating that Golden Plovers and Lapwings had been displaced by as much as 0.5 mi (0.8 km) from wind facilities in Denmark (citing Pederson and Poulsen 1991) while in Netherlands, Lapwings and Curlews avoided areas within 0.15-0.3 mi (0.25 – 0.5 km) of wind turbines (citing Winkelman 1990).

Although focused on grassland passerines rather than prairie grouse, Leddy *et al.* (1999:101) recommended placing wind plants within cropland habitats in MN rather than in native grasslands. Research at the Buffalo Ridge Project in southwestern MN revealed that the Bobolink, Red-winged Blackbird, Savanna Sparrow, and Sedge Wren nested in densities 4 times higher in grasslands that were ~ 600 ft. (180 m) from wind turbines than those within ~ 260 ft (80 m) of turbines. Densities beyond 600 ft. were not evaluated (Leddy *et al.* 1999). Because of the trend for larger turbines, avoidance zones adjacent to the new generation turbines may differ from those of previous studies (R. Manes, S. Harmon, B. Obermeyer, and R. Applegate 2004 pers. comm.). Sage-steppe-obligate songbirds (*e.g.*, Sage Sparrow, Brewer's Sparrow, Sage Thrasher, and Black-chinned

Sparrow) are also showing population declines and management concerns should also focus on these species.

The Service asserts that by avoiding or minimizing construction of wind facilities in native prairie grasslands and native sage-steppe habitats, grassland- and sage-dependent native songbird species would be protected and habitat fragmentation would be avoided.

Service's Recommendation f□r □□□ i□e B□ffer fr□□ □e□□

The intent of the Service's recommendation for a 5-mile zone of protection is to buffer against increased mortality (both human-caused and natural), against habitat degradation and fragmentation, and against disturbance. In considering our recommendation, FWS recognizes major declines in populations and habitats of prairie grouse. All species of prairie grouse are in varying stages of decline – some populations declining precipitously -- requiring a major focus on direct human impacts, disturbance from structures, and fragmentation of habitats. While wind plants are new additions to prairie grouse habitats in the Midwest and West, cumulative impacts from human development and exploitation must be assessed with great care and considerable detail. To reverse these declines will take significant commitment from industry, the Service, and other stakeholders. We view the voluntary nature of our guidance and specifically our 5-mile recommendation as a reasonable effort needed to conserve these important resources.

While migratory populations of Sage-grouse may require in excess of 11 miles in radius of protected habitat from active leks (Connelly *et al.* 2000:978), it can be argued that LPCH may require protection less than being suggested by FWS (Mote *et al.* 1998:18; 2.5 mi [4.1 km] distance from a lek located in the center of a circular home range). However, rangewide the majority of remaining LPCH populations are fragmented and isolated into "islands" of open prairie. Our 5-mile setback is intended to protect both Prairie Chickens and the wind industry. Later wind turbine construction, for example, could if in close proximity to leks significantly impact Prairie Chicken populations. Habitat corridors between leks and population centers could also be impacted by close development, likely impacting future recovery. Our distance recommendation will also help address decreasing habitat patch sizes and diminishing habitat complexity that will be affected as structures become more abundant and roads, power lines, vehicles, and human disturbance further fragment and impact habitats. Current distance recommendations for LPCHs may simply reflect the "tolerance" level of LPCHs to "structures" in fragments of < 12,350 ac (5,000 ha) in size of moderate complexity (C. Hagen 2004 pers. comm.). As patch size becomes smaller and less complex, the LPCH may likely be less tolerant of disturbance. Until data can support an alternate hypothesis, Hagen (2003:159) and C. Hagen (2004 pers. comm.) suggested protecting as large a buffer as possible for LPCH. Again, the Service's 5-mile recommendation seems reasonable (Figures 7 and 8) and applicable to all species of prairie grouse. As the necessary research is conducted to more clearly define the effects on grassland and sage-steppe species and as new data become publicly available, we will use it to refine our

recommendation.

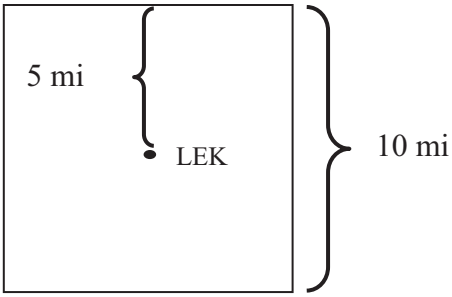

Fig 7. 100 mi^2

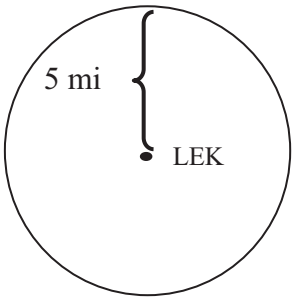

Fig 8. 78.5 mi^2

Figures 7 and 8. FWS summary of recommended 5-mile protection zone from active leks for populations of prairie grouse based on hypothetical square and circular home ranges with centrally-located leks, after S. Harmon (2004 pers. comm.), Connelly *et al.* (2000:978), Pitman (2003), Hagen (2003), C. Hagen (2004 pers. comm.), Wolfe *et al.* (2003a and 2003b), Patten *et al.* (2004a and 2004b), C. Braun (2004 pers. comm.), C. Aldridge (2004 pers. comm.), F. Hall (2004 pers. comm.), and B. Obermeyer (2004 pers. comm.).

The results from and concerns raised by a March 2003 Kansas City, MO, workshop on "Great Plains Wind Power and Wildlife" were used as further evidence by the Service to take a precautionary approach in recommending our 5-mile distance (R. Manes 2003 pers. comm.).

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Wildlife Protection Recommendations for Wind Energy Development in Wyoming

Approved By Wyoming Game and Fish Commission November 17, 2010

Much interest has been expressed in developing wind resources in Wyoming to provide renewable energy to western states, particularly California. The Wyoming Game and Fish Department (WGFD) is aware of nearly 30 new wind projects which are expected to seek regulatory approval in the next few years and we expect many additional proposals as new transmission projects enter the regulatory process. The Wyoming Infrastructure Authority, in conjunction with transmission developers, is currently studying a conceptual design capable of collecting as much as 12,000 megawatts (MWs) of new electric generation within the state. The majority of this new generation is expected to come from wind turbines. Currently, only about 1,000 MWs of wind-generated electricity is produced in the state.

The recommendations contained in this document are the result of a decision by the Wyoming Game and Fish Commission (WGFC) to address the need to protect wildlife resources while wind energy is developed in the state. The recommendations are a proactive step toward balancing Wyoming's desire to provide renewable energy to out-of-state consumers while affording adequate protection of the state's wildlife resources from activities associated with development of a wind industry.

APPLICABILITY

Ultimately, the authority to make land management decisions and approve individual wind projects rests with regulatory and surface management agencies other than WGFC and WGFD, based on principals of multiple use and sustained yield set forth by the Federal Land Policy and Management Act and the National Forest Management Act or based on impact avoidance and mitigation as set forth in the Wyoming Industrial Information and Siting Act and other state and county statutes and regulations. Neither WGFC or WGFD have regulatory authority to impose any of the recommendations contained in this document – our role is strictly consultative.

Most wind projects constructed in Wyoming, regardless of land ownership, will require a permit from the Wyoming Industrial Siting Council (WISC). W.S. 35-12-110 (b) requires WGFD to provide information and recommendations to the WISC regarding the impacts of industrial facilities (including wind projects, collector systems, etc.) subject to WISC jurisdiction and a specific recommendation as to whether the WISC should issue a permit. WGFD will use these recommendations as the basis of our consultative obligation to the WISC and in furthering our cooperating agency responsibilities under the National Environmental Policy Act (NEPA). These recommendations will also provide consistency during review of wind projects within WGFD. Except for Best Management Practice (BMP) 4, applicants may suggest site-specific alternative proposals for achieving the objectives of the BMPs outlined in Appendix A. The WGFD will

consider the applicant's proposals as we develop project-specific recommendations if the applicant can demonstrate that the alternative proposal would achieve the same level of protection outlined in the Appendix A Best Management Practices (BMPs).

Because it is prudent to be as comprehensive as possible within this document, all of these recommendations (including the best management practices and monitoring recommendations) will not be applicable to all wind projects in the state and are intended to be applied based on specific characteristics of a project site determined during pre-construction surveys and in consultation with WGFD. Early consultation with WGFD is the best means available for developers to determine which recommendations are appropriate for their project area. Project developers should consult with the WGFD at least two years prior to submitting permit applications so that appropriate studies can be conducted and site-specific recommendations can be developed. Failure to consult with WGFD early will result in delays making specific recommendations to other agencies with regulatory authority.

PURPOSE AND USE OF THIS DOCUMENT

The major purposes of this document are to provide recommendations for: 1) collecting baseline data prior to turbine siting to avoid potential conflicts with wildlife; 2) construction and operations monitoring; and 3) mitigating impacts to affected wildlife. These recommendations apply to all lands within the state. This document provides guidance under the WGFC's Mitigation Policy (WGFC 2008) and supports the WGFC's Mission of "Conserving Wildlife – Serving People."

This document provides advanced disclosure of potential wildlife-related concerns, and suggests BMPs, planning considerations including avoidance, monitoring, research and mitigation opportunities wind developers and regulatory and land management agencies can incorporate into project siting, design, construction and operations to conserve wildlife. The recommendations should be applied based on site-specific characteristics of each project area through early consultation with WGFD. Maps of crucial big game winter ranges, sage-grouse habitat (including sage-grouse core areas), priority watersheds, and other important habitats are available from WGFD.

These recommendations were prepared by WGFD staff who reviewed and incorporated pertinent literature to identify and describe reasonably foreseeable impacts to wildlife resources (refer to literature cited). A number of studies have examined effects of wind energy operations on selected species primarily birds and bats. However, there is a large gap in known information for most other species. Where appropriate WGFD gathered and interpreted information for most other species. Where appropriate, WGFD gathered and interpreted information on disturbances and activities which we believe to be comparable to those associated with wind development. While we recognize the amount of disturbances (i.e. total land disturbance), types of facilities (i.e. producing wellhead, drill rig) and intensity of activities (i.e. level of operational traffic) associated with other types of development may be more or less than those associated with wind development, the response of wildlife to those other types of development provide a reasonable means

of understanding how wildlife may react to the types of disturbances and activities associated with wind development. For example, we consulted studies of wildlife responses to oil and gas development, surface mining, humans on foot, ATVs, construction activities, roads, noise levels, etc. to generally understand and predict how wildlife would react to disturbance and activities associated with wind developments. The WGFD believes this approach, when combined with best professional judgment and field experience of WGFD biologists, affords a reasonable basis for impact avoidance, mitigation, monitoring and management recommendations contained in this document.

The state of knowledge regarding potential consequences of wind development to wildlife resources is limited. As such, we recognize and fully expect that new research, much of it likely conducted in Wyoming, will lead to the need to modify these recommendations. We welcome this new research and commit to maintaining these recommendations as a 'living document" that reflects our current understanding of the response of all the state's wildlife to wind development. We encourage input that may improve future revisions. Please direct comments to the Wind Recommendations Chairman, Scott Gamo, Wyoming Game and Fish Department, 5400 Bishop Boulevard, Cheyenne, WY 82006.

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STATEMENT OF PRINCIPLE

Potential and documented impacts of wind energy development on wildlife are a concern for wildlife population and habitat managers. In addition to the potential associated direct and indirect impacts from wind energy projects, development creates additional cumulative impacts on the landscape. Already, Wyoming has experienced impacts upon its wildlife populations from oil, natural gas, coal bed methane, coal, trona and other extractive industries. Large-scale wind development, pipelines, transmission and collector lines, potential oil shale development, and other intensive land uses can further industrialize and fragment the landscape across Wyoming resulting in site-specific and cumulative impacts to wildlife.

If public and private lands are to remain in a condition that sustains wildlife and outdoor recreation, it is imperative that all forms of energy be developed with the least possible disturbance and that the integrity and functionality of important habitat areas be maintained. This document provides recommendations to achieve these goals for wind development through a variety of project planning, siting, design, monitoring and mitigation considerations.

INTRODUCTION

Wind energy is an important component in the nationwide effort to reduce the effects of global warming associated with carbon-based fuels. Wind development in the U.S. increased by 46% in 2007, and at the end of 2007 the U.S. had the second highest cumulative wind generation capacity globally. This rate of development is expected to accelerate, as U.S. energy policy emphasizes reduction of carbon emissions. The Federal Advisory Committee on Wind (FAC) concluded that wind-generated electrical energy, from a global warming perspective, has environmental benefits including to wildlife.

Wind energy development produces electricity without air pollution, greenhouse gas emissions, significant water consumption, mining, drilling, refining, waste storage and other problems associated with many traditional forms of energy generation – all of which may result in benefits to wildlife. The U.S. Department of Energy (DOE) estimates that a single 1.5 MW wind turbine displaces 2700 metric tons of CO2 per year compared with the current U.S. average utility carbon-based fuel mix. Due to these advantages, wind is expected to play an increasingly important role in meeting the Nation's energy needs in the coming years.

In July 2003, the U.S. Fish and Wildlife Service (USFWS) issued “Voluntary Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines.” The Department of the Interior also convened a 22 member Wind Turbine Guidelines Federal Advisory Committee (FAC), which reached consensus on a set of draft recommendations aimed at minimizing the impacts of land-based wind farms on wildlife and its habitat. The interim guidelines are not mandatory requirements in Bureau of Land Management (BLM) land use plan decisions. Until the Secretary determines the applicability of final FAC guidelines for the Department of the Interior (DOI) agencies, the USFWS interim guidelines are only to be used as a general guide to assist the BLM in siting decisions and the design of pre-construction surveys, mitigation measures, and post-construction monitoring for individual projects. WGFD has reviewed the FAC draft

document and has developed our recommendations to fall within the broad guidelines contained within the latest version (Version 6, 2010).

REVIEW OF WIND DEVELOPMENT IMPACTS TO WILDLIFE

Wind development is an intensive, industrial-scale use of the land surface. Individual wind project boundaries vary in size ranging from just a few turbines on a few hundred acres upwards to 1000 or more turbines distributed across 80,000 to 100,000 or more acres. With current technology, individual turbines typically generate in the range of 1.5-2.5 MWs. Towers range from 212 to over 260 ft tall with blade sweeps of 328 ft to over 400 ft above ground level. Generally, tower height increases as generating capacity of individual turbines increase. Wind projects require a road network to facilitate access for construction and turbine maintenance. In addition, power lines (aboveground or buried) provide for the collection of electricity generated at individual turbines and delivery to substations. Collector lines connect substations at wind project sites to transmission hubs. All associated infrastructure has the potential to affect wildlife and habitat.

Wyoming has enviable diversity and abundance of wildlife. The state contains large expanses of relatively intact native ecosystems that provide the buffer necessary for animals to spatially accommodate natural or man-caused changes to their habitat. The WGFD considers loss of habitats and concurrent fragmentation of habitats as the principal concern when we evaluate potential perturbations to the landscape and the effect on wildlife species. Cumulative impacts, fragmentation of habitats, direct and indirect impacts all contribute to declines in species habitats and numbers. Although maintenance or improvement of habitat function is paramount in crucial habitats (crucial big game ranges, core sage grouse areas, etc.), the future functionality of these crucial habitats and the wildlife they support is dependent on maintaining adequate habitat connectivity across the state to ensure crucial habitat components within the state are not isolated from other crucial habitats through habitat fragmentation and construction of barriers. From this perspective, the WGFD has approached wind development as another potential impact on the state's habitat capacity which is necessary to sustain wildlife found in Wyoming. The following sections provide greater detail of some of the potential conflicts with wildlife species and wind development in Wyoming. The Appendices outline our recommended approach to identifying, understanding and ultimately avoiding and minimizing the potential detrimental effects of wind projects on many of the wildlife species in Wyoming. Coordination with the USFWS's Wyoming Ecological Services Field Office, is also important for all wind development and can help ensure compliance with Federal laws.

BATS

Wind energy developments can impact resident and migratory bats depending on site location and the species that are present. Four types of impacts are anticipated: 1) direct mortality due to collisions with turbines; 2) direct mortality resulting from rapid decompression of lungs due to changes in atmospheric pressure caused by bats passing through the rotating turbine blades; 3) indirect impacts due to displacement of bats from preferred feeding, roosting, and mating areas; and 4) indirect impacts due to alteration of migratory pathways. Additional research is required to further determine impacts to bats.

There is concern that impacts to bats from wind turbines are underestimated (Arnett 2006, Kunz et al. 2007a, Arnett et al. 2008). Because bats are small, nocturnal, and cryptic, bats are often overlooked during carcass searches, making it difficult to assess mortality accurately. Moreover, until recently, mortality surveys were aimed primarily at assessing the impacts to avian species and often failed to incorporate adequate methods to locate bats into their study design. As such, these early efforts likely underestimated impacts to bats. Researchers have hypothesized that the abundance of North American bats could be significantly reduced within the next 10 years if efforts are not undertaken to minimize turbine impacts to bats (Kunz et al 2007b).

Of the 18 bat species found in Wyoming. Almost half have been identified in turbine-related mortality assessments conducted throughout the U.S. (Johnson 2005, Arnett et al. 2008). Most of the turbine-related bat fatalities tend to occur in August and September, which appears to coincide with the migration of several species. Most of the bats killed by turbines tend to have similar life history characteristics (Johnson 2005, Arnett et al. 2008). Although all bats may have some level of susceptibility to turbine-caused mortality, in studies conducted to date, tree roosting bats, eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), and silver-haired bat (*Lasionycteris noctivagans*) comprise the majority of carcasses located during ground searches and appear to be most susceptible (Johnson 2005, Kunz et al 2007b, Cryan and Brown 2007,). Other species that are known to be susceptible are the big brown bat (*Eptesicus* fuscus), Brazilian free-tailed bat (*Tadarida* brasiliensis), eastern pipistrelle (*Pipistrelle subflavus*), little brown bat (*Myotis lucifugus*), northern long-eared myotis (*Myotis septentrionalis*) (Johnson 2005). Hester and Grenier (2005) provide a complete list of bats known to occur in Wyoming and their ditribution.

Bat mortalities are not always the result of collisions. Researchers have recently discovered that collisions with wind turbines only accounted for about half of all mortalities at a wind energy facility in south-western Alberta, Canada. Necropsies of bats located during ground carcass searches revealed that nearly 90% of all bat mortalities included internal hemorrhaging caused by rapid decompression due to negative pressures created by rotating turbine blades (Baerwald et al. 2008). Known as Barotrauma, this internal hemorrhaging was reported to be the proximate cause of death for all bats that showed no external signs of fatal injuries.

Why bats are susceptible to fatality from turbines is poorly understood. Cryan and Brown (2007) hypothesized that turbines may be mimicking features on the landscape that bats are attracted to and may serve as rendezvous sites for migration or mating. Kunz et al. (2007b) developed an additional eleven hypotheses that could explain the reasons why insectivorous bats have fatal interactions with turbines. Cryan and Barclay (2009) have recently separated existing hypotheses into proximal and ultimate causes.

> "**Linear corridor hypothesis.** Wind energy development facilities constructed along forested ridgetops create clearings with linear landscapes that are attractive to bats.
>
> **Roost attraction hypothesis.** Wind turbines attract bats because they are perceived as potential roosts.
>
> **Landscape attraction hypothesis.** Bats feed on insects that are attracted to the altered landscapes that commonly surround wind turbines.

Low wind velocity hypothesis. Fatalities of feeding and migrating bats are highest during periods of low wind velocity.

Heat attraction hypothesis. Flying insects upon which bats feed are attracted to the heat produced by nacelles of wind turbines.

Acoustic attraction hypothesis. Bats are attracted to audible and/or ultrasonic sound produced by wind turbines.

Visual attraction hypothesis. Nocturnal insects are visually attracted to wind turbines.

Echolocation failure hypothesis. Bats cannot acoustically detect moving turbine blades or miscalculate rotor velocity.

Electromagnetic field disorientation hypothesis. Wind turbines produce complex electromagnetic fields, causing bats to become disoriented.

Decompression hypothesis. Rapid pressure changes cause internal injuries and/or disorient bats while foraging or migrating in proximity to wind turbines.

Thermal inversion hypothesis. Thermal inversions create dense fog in cool valleys, concentrating both bats and insects on ridge tops."

Preliminary information suggests that the fatalities of bats at wind energy development facilities may be predictable events following certain weather patterns (Cryan and Brown 2007, Arnett et al. 2008). Hoary bat migrations appear to be predictable events following nights with high cloud cover, low wind, and low barometric pressure. Other studies in the eastern U.S. support the conclusions of Cryan and Brown (2007) and reported that fatalities were higher on nights with light winds (Arnett et al. 2005, Arnett et al. 2008). Overcast nights and low barometric pressures are also consistent with observed migration patterns for passerine birds (Alerstam 1990), suggesting that both birds and bats migrate under similar conditions coinciding with the passage of cold fronts.

PASSERINES AND RAPTORS

An estimated 33,000 birds are killed annually in the U.S. by wind turbines and, according to a study by Smallwood (2007), this estimate may be biased low. This number contributes to cumulative impacts of all bird collision mortality in the U.S., e.g. collisions with telecommunications towers, collisions with moving vehicles, and collisions with structures. Out of the 33,000 birds killed annually, 26,600 are killed in California alone due to the sheer number of turbines and certain outdated turbine designs that are in place (Erickson et al. 2001). Outside of California, approximately 1.83 birds are killed per turbine per year (corrected for searcher efficiency and carcass loss to scavenging) (Erickson et al. 2001). As the number and height of wind turbines increase across the U.S., there may be a corresponding increase in the number of annual bird mortality figures (Mabey and Paul 2007).

Direct impacts to birds themselves include injuries or fatalities from collisions during flight with wind turbine rotor blades, monopoles, power lines, guy wires, and other related structures (Kunz et al. 2007a, Winegrad 2004). Most species of birds are at risk of collisions, although studies have shown that specific groups of birds in particular habitats, under certain weather conditions,

or in large densities are more at risk than others, including raptors, migrating birds, wading birds, and waterfowl (Becker et al. 1999, Erickson et al. 2001, Rugge et al. 2003, Kingsley and Whittam 2007, Kuvlesky et al. 2007).

The design, placement, and layout of wind turbines can determine the vulnerability of birds to collisions, especially where species are more likely to collide with structures due to relative abundance, behavior, topography, and linkage with specific habitats (Erickson et al. 2002, Hoover and Morrison 2005, Kuvlesky et al. 2007, Rugge et al. 2003). For example, additional impacts to raptors are created when turbines are sited on steep slopes and hillsides, in canyons and draws, on ridge crests and peaks within canyons, and when rock piles that attract prey species are located near turbines (Hoover and Morrison 2005, Kingsley and Whittam 2003, Smallwood and Thelander 2004). Grassland birds that engage in aerial displays during courtship, such as the long-billed curlew, upland sandpiper, vesper sparrow, horned lark, chestnut-collared longspur, and McCown's longspur, have a greater risk of colliding with rotor blades that occur within a male's territory (Ehrlich et al. 1988, IDNR 2007, Fellows and Jones 2009).

Based on relative abundance, passerines comprise the majority of fatalities from wind turbines with newer designs (taller towers with larger rotor blades and slower rotor speeds), with the peak of fatalities occurring during migration (Erickson 2004). Migrants that funnel through a concentrated migration corridor or along landforms such as ridges, steep slopes, and valleys are more at risk of collisions if turbines also occur in these areas (Kingsley and Whittam 2003, IDNR 2007). Most night migrants fly between 300-2,000 feet (91-610 m), so the risk of collision is expected to increase as tower height and rotor diameter increase and tip speed decreases (Kerlinger 2004, Smallwood and Thelander 2004, Morrison 2006). Collision mortality estimates vary from site to site throughout the U.S. and are presently not thought to have a impact on populations of passerines (Erickson et al. 2002); however, bird collision fatalities from wind projects constructed in bird migration routes and corridors remain a justifiable concern (Erickson et al. 2005). Collision mortality of raptors, however, may impact populations due to the longer life span and lower reproductive potential of raptors compared to passerines (Kuvlesky et al. 2007). The most common fatalities of raptors at the Altamont Pass Wind Resource Area in California include the red-tailed hawk, burrowing owl, American kestrel, and golden eagle (Orloff and Flannery 1992, Thelander and Rugge 2000, Smallwood et al. 2007). The relative abundance of these species being struck by wind turbines was disproportionate to their frequency of fatality. Some species are apparently more susceptible than others to the risks posed by wind turbines (Thelander and Rugge 2000).

Direct impacts due to habitat loss, modification, and fragmentation from land use changes associated with wind development may render sites unsuitable for birds and may have the greatest adverse impacts to bird communities (Kuvlesky et al. 2007). Long-term impacts are caused by the cumulative footprint of the turbine towers, roads, power lines, and supporting infrastructure that removes or alters habitat, which displaces birds from preferred habitat, shifts birds to less desirable habitat, and causes birds to avoid impacted areas (Rugge et al. 2003, Smallwood and Thelander 2004, Strickland 2004).

Grassland songbirds are very sensitive to disturbance and fragmentation of grassland habitat and vertical structures within grassland habitat, particularly area-sensitive species such as the grasshopper sparrow, dickcissel, and bobolink that require large expanses of intact habitat (Leddy et al. 1999, Nicholoff 2003, IDNR 2007,). Studies have shown that habitat use by grassland passerines and prairie grouse was lower in study plots containing wind turbines than in study plots without turbines (Leddy et al. 1999, Johnson et al. 2000), with the actual distance depending on the species, and likely ranging from <330 feet (<100 m) to 2 miles (3 km) (Strickland 2004). In other studies, differences in breeding density for grassland species in relation to proximity to wind turbines varied by species, with some species appearing to be more sensitive to the turbines than others (O'Connell and Piorkowski 2006).

Research conducted in sagebrush-steppe habitat with dirt roads and a low volume of traffic showed that density of sagebrush obligate birds was reduced by 39-60% within a 328-foot (100 m) buffer around roads (Ingelfinger and Anderson 2004). This study raises concern about the impacts of roads created during industrial developments and the possibility that the presence of obligate species and area-sensitive species may decline if the habitat they require is removed or compromised. Roads are a direct cause of habitat loss and fragmentation, thereby reducing both habitat quantity and quality. An increase in roads will also increase bird-vehicle collisions and reduce native plant biodiversity by facilitating the introduction and spread of invasive plants and noxious weeds (Erickson et al. 2005, Kuvlesky et al. 2007).

Indirect impacts occur when habitat and landscape alterations disrupt foraging behavior, activities associated with breeding, and migration patterns (Kunz et al. 2007a). Studies have reported displacement effects that range from approximately 250-2,600 feet (75-800 m) away from wind turbines (Leddy et al. 1999, Strickland 2004). Large wind projects may also create a barrier along migration paths or between foraging and roosting areas, causing a behavioral shift in birds, avoidance of habitats associated with and adjacent to wind projects, and an increase in the amount of energy expended during movements (Winegrad 2004, Drewitt and Langston 2006). Birds may avoid habitat at and surrounding wind projects due to the presence of continuous motion and constant noise. Although not well studied, reports suggest that changes in wildlife behavior and habitat use may occur in response to shadow flicker, which is caused by sunlight passing through the rotating blades of wind turbines (IDNR 2007). Passerines that occur in open habitats may be most affected, as the rapidly moving shadow may resemble the flight of an aerial predator, causing both behavioral changes and an increased stress level (IDNR 2007).

Excessive or continuous noise can interfere with the vocal communication of birds, particularly during the breeding season (March through July for most raptors and April through July for most passerines). It is important to note that not all turbines are in operation 24 hours a day. Therefore, for the purpose of this document, "continuous noise" is noise that occurs while these facilities are in operation or while any residual noise is occurring (e.g. power lines). In addition, for the purpose of this document, "excessive noise" is noise that is detected by the listener above ambient noise levels (Rogers et al. 2006). Birds that rely on vocal cues to attract and retain mates and defend territories can be particularly sensitive to noise. Continuous noise produced by turbine engines and rotor blades and noises associated with substations, power lines, and routine maintenance (e.g. vehicular traffic, motorized equipment) may adversely affect territory

selection and defense, foraging and fledging success, song learning, and dispersal (Nicholoff 2003). Excessive noise can also produce stress in individual birds, resulting in avoidance of impacted areas and lower population densities within impacted areas. The effects of continuous noise on bird communities are greatest where noise levels exceed 50 dBA; however, even moderate noise levels of 40 to 50 dBA may negatively impact bird communities (Nicholoff 2003).

Both direct and indirect impacts from wind development can contribute to increased mortality of birds; changes in food availability; nesting, roosting, and staging site availability; and an increased risk of predation (NRC 2007). These impacts can also result in a reduction in nesting density in a developed site, behavioral changes such as avoidance or abandonment of preferred habitat, and occupancy of marginal habitat. Ultimately, facility size and design and the areas in which turbines and other infrastructure are located will dictate the degree of impact that wind projects have on birds.

GREATER SAGE-GROUSE AND SHARP-TAILED GROUSE

In Wyoming, some of the most economically attractive wind development sites are often within native shrub or grassland ecosystems inhabited by greater sage-grouse (*Centrocercus urophasianus*), plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi) or Columbian sharp-tailed grouse (T.p. columbianus*). Wind development alters site characteristics through placement of tall structures (towers and power lines) and road networks (Braun 2006 and others). Prairie grouse did not evolve with these types of features in their environment. Older turbine designs produced noise levels well above the threshold of 49 dBA known to impact breeding birds (Ingelfinger 2001, Nicholoff 2003). For example, overall noise levels measured during a moderate wind day at the Altamont Pass Wind Energy Project were about 70 dBA (Dooling 2002). New turbine designs produce less noise. Turbines also produce motion and project moving shadows onto the ground. These types of habitat alterations may cause impacts to prairie grouse and a variety of other wildlife adapted to treeless environments. Sage-grouse were determined to be "*warranted but precluded"* for listing under the federal Endangered Species Act by the USFWS (March 2010) and Columbian sharp-tailed grouse have been petitioned for listing twice.

Several planning documents and environmental analyses have noted that peer-reviewed studies specific to prairie grouse are lacking and additional research is needed to determine if anticipated impacts are occurring and to what degree (USFWS 2003, Manville 2004, Governor's Sage-Grouse Conservation Team 2004, Sharp 2005, Strickland 2005, Stiver et al 2006:5-1, Southwest Wyoming Sage-grouse Working Group 2007:38, Bates Hole/Shirley Basin Sage-grouse Working Group 2007:74). Mabey and Paul (2007) observed, "The most common studies about the impact of wind facilities on birds in grassland and shrub-steppe habitats document mortality at specific facilities. This is not unexpected; most studies are commissioned by wind energy companies to determine potential and actual mortality to satisfy regulatory concerns. Thus far, regulators seem to be concerned primarily, if not exclusively, with mortality. A much smaller set of studies document behavioral responses (e.g., changes in flight behavior) or effects on breeding bird density or distribution." Strickland (2004:34) stated, "Indirect loss of habitat may occur from birds' behavioral responses to development, such as avoiding wind plant facilities and areas

surrounding them. Long-term habitat impacts result from the construction of relatively permanent structures that remove habitat for the life of a project and from birds avoiding habitat disturbed by a wind farm and not habituating (i.e., becoming accustomed) to wind farm features." Strickland (2005) recommended a *Before-After Control-Impact* (BACI) sampling design to evaluate non-fatality impacts when it is possible to collect pre-construction data.

Although wildlife resource agencies have identified a critical need to conduct studies documenting avoidance effects and changes in population demographics associated with wind development, such studies have not been widely done. This is particularly problematic for sage-grouse, which are highly sensitive to disturbances and habitat modifications.

Due to the lack of specific wind related research, studies of other developments involving similar infrastructure components and disturbances provide some insight into the impacts of wind development on prairie grouse (Manville 2004, Strickland 2004, Sharp 2005). For example, studies examining the impacts of roads, power lines, communication towers, and noise in natural gas fields are relevant in ascertaining how native prairie grouse are likely to respond to wind development. Movement and noise associated with turbines and road traffic, in particular, are expected to cause some level of avoidance based on similar avoidance effects observed at large-scale natural gas development (see Lyon 2000; Lyon and Anderson 2003). But specific research is needed to identify these effects.

Anticipated impacts of wind development specifically include: collisions with turbine blades, fences, guy wires, power lines, and vehicles; behavioral avoidance and habitat fragmentation; auditory and visual disturbance; increased predator access; poaching; spread of invasive weeds; and increased fire frequency (Leddy et al. 1999, USFWS 2003, Connelly et al. 2004, Manville 2004, Sharp 2005, Schroeder et al. 2006). Impacts from power lines include: behavioral avoidance, habitat fragmentation, collisions, and increased predator access (Aldridge 1998, Braun 1998, Connelly et al. 2000, Boisvert 2002, Braun et al. 2002, Hagen 2003, Wolfe et al. 2003a, 2003b, Pitman 2003, Connelly et al. 2004, Hagen et al. 2004, Patten et al. 2005 and Hoffman and Thomas 2007). Lacking specific research, it is prudent to expect that industrial-scale wind development will have impacts on both sage-grouse and sharp-tailed grouse primarily due to habitat alterations and behavioral avoidance. However, direct mortalities from collisions are not expected to be a problem if turbines are sited outside major movement corridors.

Collisions between fowl-like birds and turbines are less common than collisions involving other species, especially passerines and bats. Summarizing the results of 5 studies in the U.S. outside California, Erickson et al. (2001:37) reported 4.0% of birds killed in collisions with wind turbines were fowl-like species. Three of the studies reported no mortality of fowl-like species, one reported 5.5% of the birds killed were fowl-like species and an Oregon facility reported 25% of the birds killed were fowl-like species. Strickland (2008) found that, relative to their abundance, game birds comprised 11% of the fatalities analyzed nationwide. Braun (cited in Manville 2004) believed sage-grouse could avoid collisions with turbines due the large size and visibility of these structures. Most prairie grouse typically fly below the sweep of turbine blades. However, WGFD biologists have observed sage-grouse flying at fairly high elevations above ground when moving long distances. The potential for grouse to collide with turbine blades should not be discounted if turbine strings and power lines are located within migratory

pathways between habitats used on a daily or seasonal basis. In addition, collisions with barbed wire fences are fairly common and potential for collisions with guy wires and power lines is recognized by several authors (Connelly and Braun 1997, Becker et al. 1999, Schroeder et al. 1999, Connelly et al. 2004, Manville 2004, Connelly 2005, Braun 2006, Stemler 2007).

Several studies have also documented a "shadow flicker" effect resulting from the projection of moving turbine shadows onto the ground, roads, or buildings (Nielsen 2003, DWEA 2003, Hotker et al. 2006:24, National Research Council 2007, Hewson 2008). There is speculation that this "flicker" effect may resemble avian predators and disturb grouse and other small prey species that are sensitive to avian predation from overhead. Specific research examining this issue is needed.

Impacts to sage-grouse and sharp-tailed grouse from wind development have not been specifically studied, but information from other energy studies lend some insight. For prairie grouse, there is a considerable body of literature describing impacts of roads, power lines, and natural gas wells. Roads with light traffic (1-12 vehicles/day) were correlated with less successful nesting by sage-grouse hens (Lyon 2000). Light traffic near leks may also reduce nest-initiation rates and increase distances hens move from leks during nest-site selection (Lyon and Anderson 2003). In addition, Braun (1998) determined habitat use by sage-grouse was impacted by power lines up to a distance of at least 600 m. Other studies have indicated little or no impact from power lines. In Montana habitat selection was modeled for three sage-grouse populations in Beaverhead County based on a radio telemetry study involving 45 male sage-grouse during the summers of 2001 to 2005. One of the parameters used in the model was distance to the nearest power line. However, the distance to power line variable was not found to be associated with sage-grouse habitat selection, suggesting that presence of transmission lines did not affect habitat selection by the male sage-grouse monitored during this study (Wisinski 2007).

Recent studies have determined that sage-grouse leks are impacted by nominal levels of natural gas development equating to 1 well pad/mi^2 within 2 miles, and are highly impacted when development exceeds 2-3 well pads/mi^2 (Naugle et al. 2006, Walker et al. 2007, Doherty 2008, Walker 2008, Doherty et al. 2008, Naugle et al. *in press*). Wind developments typically contain much higher densities of tall structures that are associated with motion and shadow flicker.

Concerns exist that wind development will cause significant adverse impacts to sage-grouse and sharp-tailed grouse if they are sited in habitats that are important to those species. After a wind farm was build in alpine habitat, in Austria, five years of monitoring data on black grouse (*lyrurus tetrix)* populations showed a decrease in their population (Zeiler, Hubert P, Granschachner-Berger, Veronika. 2009). Naugle et al. (*in press*) has described the mechanism of this impact: "Recent research shows that sage-grouse populations decline when cumulative impacts of development negatively affect reproduction or survival (Aldridge and Boyce 2007), when birds behaviorally avoid infrastructure in one or more seasons (Doherty el al. 2008), or both (Lyon and Anderson 2003; Holloran 2005; Kaiser 2006). Behavioral avoidance of energy development reduces the distribution of sage-grouse and may result in population declines if density-dependence or habitat suitability lowers survival or reproduction in displaced birds (Holloran and Anderson 2005; Aldridge and Boyce 2007). Adult female sage-grouse in Canada

led their young into the Manyberries Oil Field where succulent forbs were abundant, but despite this attraction, the oil field was a population sink where risk of chick mortality increased 1.5 times for each additional well visible within 1 km of the brood (Aldridge and Boyce 2007). In the Powder River Basin, sage-grouse were 1.3 times less likely to use otherwise suitable winter habitats that have been developed for coal bed methane (12 wells/4 km^2), and differences were most pronounced in high quality winter habitat with abundant sagebrush cover (Doherty et al. 2008). However, current research (G. Johnson, Pers. comm.) has documented the current use of sage grouse leks within one mile of an established wind project after 2 years of construction. Continued long-term persistence of these leks still needs to be evaluated to account for lag affects (Holloran 2005).

Plains sharp-tailed grouse may be somewhat more adaptable to changes in their environment than are sage-grouse. Nebraska Game & Parks Commission staff has been monitoring greater prairie chicken and sharp-tailed grouse leks near the Ainsworth Wind Energy Facility. All 13 leks have been active each of the three years since construction, and the number of birds on the leks has remained stable. These leks are 0.3-1.59 miles from the nearest turbine (avg. = 0.66 miles) (Nebr. GPC, Pers. comm.). Baydack and Hein (1987) found that male sharp-tailed grouse continued to display on leks when confronted with several types of experimental disturbance treatments. However, female sharp-tailed grouse were not observed on any lek during disturbance treatments. Sensitivity of females may limit reproductive success at lek sites exposed to disturbance. Others have documented this disturbance mechanism among female sage-grouse in an area of natural gas development (Lyon 2000, Lyon and Anderson 2003). In addition, yearling male sage-grouse were recruited onto disturbed leks at a lower rate than on undisturbed leks (Braun 1986; Kaiser 2006; Walker 2008), resulting in a time lag between the onset of disturbance and the ability to detect an impact (Walker 2008).

Several researchers and managers have recommended set-back distances to protect leks and other important habitats from disturbances caused by development. Set-back distances are intended to buffer the disturbance reaching the lek and surrounding habitat in order to maintain effective habitat conditions. The distances vary depending on whether the goal is to simply minimize disturbance to the lek itself, or to also protect nesting and brood-rearing habitats that are associated with the lek. These recommendations and research findings provide additional insights regarding the distances at which wind development is expected to adversely affect prairie grouse.

MIGRATORY WATERFOWL, WATERBIRDS, AND SHOREBIRDS

Wind developments may impact migratory game birds and waterbirds depending on site location and species that are present. As with other bird species, three types of impacts are anticipated: 1) direct mortality due to collisions with turbines, power lines, and meteorological towers; 2) displacement of migratory birds from preferred feeding, resting, or nesting areas; and 3) alteration of migratory pathways.

Waterfowl typically fly at heights and distances that put them at risk for collisions (Mabey and Paul 2007). Erickson et al. (2001) reported 78% of the carcasses found in 31 studies of wind projects were passerine species. However, wetland-associated species comprised the second

largest category of collision mortalities and included waterfowl (5.3%), waterbirds (3.3%), and shorebirds (0.7%). Projects with sources of open water near turbines (e.g., San Gorgonio, California, and Buffalo Ridge, Minnesota) have the highest documented waterfowl mortality, with 10 to 20% of all fatalities consisting of waterfowl and shorebirds (BLM 2005:5-63). In addition, collisions with power lines are an important source of mortality for several species of waterbirds (Fiedler and Wissher 1980, Crivelli et al.1988, Morkill and Anderson 1991, Pacific Flyway Study Committee 2002, Manville 2005, Rubolini et al. 2005).

Weather can increase the incidence of collisions with tall structures, in particular with regard to nocturnal migrants (Mabey and Paul 2007:103). For example, most Trumpeter Swan (*Cygnus buccinator*) collisions with power lines and fence wires occurred during winter fogs (Banko 1960). Presence of fog at wetlands with high waterfowl densities contributes to waterfowl mortality associated with power lines (Andersen-Harild and Block 1972). The same concern would likely apply to wind turbines if they are sited near wetlands.

The potential for avian collisions was a major issue prior to construction of the Forward Energy Wind Project near the Horicon National Wildlife Refuge in Wisconsin (USFWS 2004). Ultimately, the project sponsor was required to set all wind turbines back at least 2 miles from the refuge property boundary (Public Service Commission of Wisconsin 2005:19).

Displacement of waterfowl from wind development has been investigated in coastal regions of Europe where this is considered to have a greater impact on birds than collision mortality (Strickland 2004). Studies suggest most displacement involves migrating, resting and foraging birds. Displacement distances range from 75 to 800 m away from turbines (Strickland 2004). Sea ducks including long-tailed duck (*Clangula hyemalis*), common eider (*Somateria mollissima*), and common scoter (*Clangula hyemalis*) are particularly vulnerable to turbine impacts (Gill *et al.* 1996; Langston and Pullan 2003; Garthe and Hüppop 2004; Stewart et al. 2007:6). Krijgsveld (2007) also reported pochards (*Aythya ferina*), mergansers (*mergus spp.*) and goldeneyes (*Bucephala clangula*) were disturbed by an operating wind project in the Netherlands, although several other species did not appear to be affected.

Waterbirds and waterfowl may avoid feeding in areas near wind turbines (IDNR 2007, Kingsley and Whittam 2003); however, in areas near wetlands or other areas of waterfowl concentration, these birds are at more risk of collision when entering and departing the area (IDNR 2007). Although shorebirds have a lower risk of collisions with turbines due to the height at which they migrate, wind turbines located near shorebird feeding and staging area can be detrimental during takeoff and landing, particularly if birds are disturbed and forced to flee (Kingsley and Whittam 2003). Turbine design, including height, blade length, rotor tip speed, blade appearance to birds, and the presence and type of lighting, also plays a role in collision risk (Kuvlesky et al. 2007).

In addition to displacement, wind turbines can have a barrier effect, causing waterfowl, wading birds, and shorebirds to alter migration paths considerable distances (Noer et al. 2000, Percival 2001, Bruns et al. 2002, Christensen et al. 2002, Langstron and Pullan 2002). Krijgsveld (2007) made the following observation in the Netherlands: "Water birds were found to avoid the wind energy development on a large scale when the turbines were moving. During turbine operation, the number of flight movements *outside* the wind farm was much greater (85% during the day,

75% during the night) than flights *through* the wind farm. Waterbirds made long deflective flights to avoid the wind farm when the turbines were moving … When turbines were not moving, birds cut through the wind farm."

Although these studies were done predominantly within coastal regions, it is reasonable to anticipate similar effects on waterfowl and other wetland-associated species if turbines are sited within or near freshwater marshes, streams, and lakes.

BIG GAME

The effects of wind energy development on large ungulates are largely unknown. There has been little research completed on the subject to date, although ongoing monitoring and research in Wyoming is expected to begin to provide information within the next few years.

Direct ungulate habitat loss from wind energy development surface disturbance may be relatively small as turbines and roads typically constitute only a small percentage of the development area. However, indirect habitat impacts, those affecting use of undisturbed and adjacent portions of the project area by ungulates may be much larger. For instance, habitat security, an important factor in determining use of habitats by many big game species, may be compromised.

Estimates from the Foote Creek Rim Project in Wyoming suggest that long-term surface disturbance was 0.7-1.0 acres per turbine, or 0.4-0.7 acres per MW (Strickland 2004). Although actual disturbance associated with wind turbines and their associated roads and other infrastructure is relatively small, indirect impacts may affect much larger areas. Consequently, the potential exists to displace big game species from important seasonal habitats particularly crucial winter ranges. In addition, if displacement does occur additional impacts could include a loss of connectivity between necessary seasonal habitats including migration routes, parturition areas and important summer ranges all of which provide essential habitat components to maintain big game populations across Wyoming. The lack of connectivity may fragment habitats, resulting in a decrease in the quality and attractiveness of remaining patches of habitat in areas adjacent to infrastructure (Berger et al. 2006).

Wyoming is home to the largest number of pronghorn antelope in the U.S. (and the world as they are a distinct North American species). Current estimates are at 526,000 (WGFD 2009 Annual Report). Pronghorn primarily inhabit open landscapes comprised of sagebrush steppe or grassland habitat types. These areas often coincide with economically attractive wind. Mule deer also use these landscapes for year round habitat or as seasonal winter ranges. Potential impacts to pronghorn and mule deer include direct and indirect habitat loss, displacement, and cumulative impacts associated with other nearby energy development.

Pronghorn and mule deer have been observed to maintain populations in developed areas such as surface coal mines (Segerstrom 1982, Medcraft and Clark 1986, Gamo and Anderson 2002). Others (Sawyer et al. 2006) have found mule deer remain, but at reduced populations, in response to natural gas development. Sawyer et al. (2006) and Berger et al. (2006) found that mule deer and pronghorn exhibited avoidance behavior of gas development areas or selected habitats away from development. Wind projects also have road networks, other infrastructure

and human activity; however, the impact may be different as wind projects generally require fewer roads, less operational traffic, and different types (and sizes) of permanent structures.

It is difficult to predict the impact of wind development in Wyoming to big game species. There is a need for research, as has occurred with oil and gas development, to identify and assess the impacts of wind development and determine appropriate mitigation for these species.

To date there has been one single study performed on the direct effect of wind development on elk (Walter et. al. 2006). This study found that elk were displaced from wind development activities during construction but after construction was completed less displacement was noted. However, caution is warranted in applying the results of this study to large free-roaming elk herds found in Wyoming as Walter's study was performed on a non-migratory herd of elk in southwestern Oklahoma. This herd was adjacent to a very large high-fenced wildlife refuge. The fence limited their movement to those habitats behind the fence, which were away from the wind development activities. This herd also inhabited an area of many small tract-private agricultural lands that are intersected by road systems and residential developments. These elk were likely more habituated to human presence than Wyoming elk would be and likely do not accurately represent the majority of Wyoming's elk herds.

In other published literature (Perry and Overly 1977, Rost and Bailey 1979, Lyon 1983) elk have been demonstrated to be highly sensitive to disturbance from vehicle traffic and will actively avoid roads. Many of these studies evaluated elk response to logging or other forest use activities. The network of roads that is constructed for wind projects in elk habitat could displace elk depending upon the amount of human activity. Increased human activity, often associated with roads, can displace elk, resulting in increased movements and associated energetic costs (Rumble et al. 2006).

Another big game species potentially affected by wind development in Wyoming is bighorn sheep. Some lands near bighorn sheep populations have been leased for wind development in the Laramie Range. Bighorns often inhabit relatively treeless ridges or mountainsides (Gionfriddo and Krausman 1986). During winter bighorns can be found on windswept ridges foraging in areas with less snow (Tilton and Willard 1982). As with elk, bighorns are sensitive to human activity and have more strict requirements in habitat needs (Smith et al. 1991). There is currently a lack of information specific to the potential effects of wind development on bighorn sheep but it is WGFD's experience that they are one of the more disturbance-sensitive big game species.

SMALL MAMMALS

Impacts to small mammals from wind development are largely unknown and will likely vary depending on site location and species present. Several types of impacts could potentially occur, however others not yet identified are also possible: 1) mortality due to ground-disturbing activities; 2) displacement of small mammals from preferred feeding areas; 3) disturbance due to "shadow flicker"; 4) disturbance due to noise; 5) loss of burrows and escape cover; and 6) injury and mortality due to vehicle collisions.

Information describing impacts of wind development to small mammals is lacking. Both individuals and populations could be impacted both positively and negatively. Except in the case of rare species (such as the Wyoming pocket gopher, Preble's meadow jumping mouse, etc.), impacts to small mammals are often perceived as minimal and of lower priority when compared to other more conspicuous species, such as avian or volant mammals. Although small mammals are unlikely to collide with turbines, they are vulnerable to surface disturbing activities and colliding with vehicles. The construction of turbines and associated infrastructure is likely to have localized impacts on populations and individuals and the impacts will vary depending on the species life history (e.g., semi-fossorial, body size, diet, etc), abundance, and habitat requirements. Additional data is needed.

AMPHIBIANS AND REPTILES

In general, information regarding the affects of wind energy development on Wyoming's herpetofauna is lacking. It has been shown that reptile and amphibian species are affected by energy development differently based upon unique characteristics of its life history (Hampton et al. 2010, Smolensky 2008). However, there is no clear trend on generalized impacts. Permanent bodies of water, wetlands, ephemeral pools, and playas are of particular concern because amphibians are highly dependent on water to complete their lifecycle (aquatic tadpole or larval phase). Any natural or human-caused loss of water on the landscape during the larval period could negatively affect amphibian populations. This effect could be exacerbated with successive years of water loss. While we understand that wind turbines would not typically be constructed in areas important to amphibian life cycles, we remain concerned that without adequate pre-construction surveys, roads, buried power lines and other ancillary facilities could be constructed in habitats important to amphibians and that localized, long-term population impacts may occur. We are also concerned that off-site transport of sediment from construction sites may adversely affect the quality of habitats important to amphibians.

Amphibian road mortality may increase during specific times of year based upon species-specific breeding chronology. Spring breeding migrations and summer post-metamorphic emergence, result in amphibian congregations which could result in locally significant mortality events if these congregations were located on or near roads or other ground-disturbing activities. It is particularly important that data be collected for amphibians and habitats, particularly for those species which are considered Species of Greatest Conservation Need (SGCN) in the State Wildlife Action Plan, to ensure that impacts are minimized.

As with amphibians, specific information regarding the effects of wind energy development on reptiles is also lacking. While development could increase basking opportunities for many reptiles, adverse effects could occur to daily routines from human presence, surface disturbance, traffic, and noise. Many reptile species are dependent on rocky outcroppings or accessible geologic features for hibernation, and thus, it is suggested that these features be avoided to ensure the integrity of hibernacula (overwintering areas or dens).

MANAGEMENT CONCERNS

In addition to concerns about wind development on the impacts of wildlife and habitat are issues associated with the management of game species within development areas. Population management requires the use of hunting as a tool for managing species at population levels acceptable for sportsmen and sportswomen as well as trying to meet the needs of private landowners whose lands contribute to available habitat for wildlife. Development of wind energy on public land creates potential access, and public use concerns while development on private land has the potential for restricting public access open in the past, particularly for hunting. Maintaining hunter access to formerly available lands that are developed for wind energy is vital to enable WGFD to successfully manage game populations and the habitats upon which they depend, to maintain the quality of the hunting experience in Wyoming, and to reduce subsequent overcrowding of remaining public areas used by hunters.

Access to public land in Wyoming will not immediately be affected by the development of wind. To close access to public land Federal land management agencies would be required to institute an official closure, which would consist of issuing a public notice with a comment period. This includes access for hunting. However, access on private land would be dependent upon the lease agreement between the wind developer and the private landowner. The WGFD recognizes the rights of private landowners and will respect the decisions they make regarding access to their lands. However, no-hunting stipulations due to the presence of wind development on lands whose owners typically provided access, would severely impact the ability of WGFD to control wildlife populations. In addition, WGFD is committed to working with private landowners, wind developers, local law enforcement and land management agencies to help minimize and report damage to wind turbines or meteorlogical towers caused by vandals with firearms.

AQUATIC CONCERNS

A common assumption is that aquatic wildlife impacts are unlikely to be associated with wind projects. In many cases, that assumption would be correct. For example, wind turbines are often placed on the highest possible topographic features in a project area to access stronger and steadier winds found at higher elevations. As a result, turbines are rarely located in low spots where permanent or ephemeral riparian habitats usually occur. Furthermore, the aridity of Wyoming's climate, combined with the rarity of riparian habitats, creates a reduced potential for impacts to aquatic habitats relative to other regions with more precipitation.

Currently, there is a relatively small body of research on the effects of wind development on aquatic habitats. This can be partially explained by the relatively few potential wind/aquatic conflicts that have been identified at wind projects in the past and the recent nature of wind development proposals. However, there is much information on the impacts of roads and pads and culverts, associated with various forms of development, on how water runs off the landscape and how sediment is mobilized and delivered to watercourses. The combination of runoff changes and sediment delivery changes, associated with any project, has the potential to modify the aquatic habitat characteristics of stream channels.

Aquatic habitat changes may occur if roads and pads affect the infiltration rate of water, by increasing the velocity and quantity of water running across the landscape, and potentially increasing erosion and sediment deposition into nearby waterways. When erosion occurs, stream channels respond to the increased sediment supply by adjusting their pattern (sinuosity) and dimensions. These changes may result in decreased pool depths, decreased riffle area, less diversity in channel substrate and increased lateral instability marked by eroding banks. These changes along with direct effects from increased sediment loading can affect macro invertebrate populations and diversity and decrease fish habitat. A common impact is a decrease in gravel and cobble used by spawning fish.

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APPENDIX A
WIND ENERGY DEVELOPMENT
BEST MANAGEMENT PRACTICES

These recommended Best Management Practices apply only to the activities of wind developers and their contractors and subcontractors.

1. Our recommendations (including the best management practices and monitoring recommendations) may not be applicable to all wind projects in the state and are intended to be applied based on specific characteristics of a project site determined during pre-construction surveys and in consultation with WGFD. Early consultation with WGFD is the best means available for developers to determine which recommendations are appropriate for their project area. These recommendations apply only to that portion of collector lines located within a wind generation project area boundary. Recommendations for collector lines outside of a wind generation project area boundary and for transmission lines will be developed on a case-by-case basis.

2. We recommend project developers engage early with the USFWS to obtain their input on siting, monitoring and potential impacts to wildlife and habitat.

3. Project developers should consult with the WGFD at least two years prior to submitting permit applications so that appropriate studies can be conducted and site-specific recommendations can be developed.

4. Wind development is not recommended in sage grouse core areas.

5. Developers should use the statewide wind energy/wildlife conflict map (GIS shapefiles available at http://gf.state.wy.us/habitat/ TerrestrialHome/ WindDevelopment/index.asp) as one of the first steps in evaluating the suitability of leases and pre-development planning.

6. To the extent practicable, site wind turbines and ancillary project components within habitats/areas already affected by other forms of development (e.g., cropland, oil and gas fields, mine sites).

7. Developments proposed within 2 miles of WGFD wildlife habitat management areas should be coordinated with WGFD to avoid or minimize impacts to associated wildlife species and habitats.

8. Developments proposed within 2 miles of federal wildlife refuges should be coordinated with WGFD and USFWS to avoid or minimize impacts to associated wildlife species and habitats

9. Avoid placing turbines in documented locations of any species of wildlife, fish, or plants protected under the Federal Endangered Species Act.

10. Within 2 miles of the perimeter of an occupied non-core SAGE GROUSE lek, construction activities should not occur between March 15 and May 15. The WGFD recommends that developers monitor leks subject to this recommendation to evaluate its effectiveness in reducing the impacts of wind development on sage-grouse.

11. A habitat map delineating vegetation types should be developed for each project.

12. Any construction/development activities within 2 miles of the perimeter of occupied Plains and Columbian sharp-tailed grouse leks should be suspended from April 1 – July 15.

13. Turbines and all related above ground infrastructure, including roads, should occur outside a 0.25 mile (no surface occupancy) distance from the perimeter of sage-grouse leks in non-core habitat.

14. Turbines and all related above ground infrastructure, including roads, should occur outside a 0.25 mile (no surface occupancy) distance from the perimeter of plains sharp-tailed grouse leks.

15. Turbines and all related above ground infrastructure, including roads, should occur outside a 0.6 mile (no surface occupancy) distance from the perimeter of Columbian sharp-tailed grouse leks.

16. Avoid siting wind energy facilities within crucial big game ranges including crucial winter, identified parturition, and migration corridors.

17. If siting within big game winter ranges cannot be avoided, suspend construction activities from November 15-April 30.

18. If siting within identified big game parturition areas cannot be avoided, suspend construction activities from May 1-June 15.

19. Avoid placing wind energy facilities in locations that bisect major big game migration corridors as determined by on the ground mapping.

20. To the extent practicable, roads and fences should not bisect or run immediately adjacent to any natural water feature potentially preventing wildlife from reaching adjacent habitat.

21. To the extent practicable, herptile habitats for SGCN species, such as fallen trees, prairie dog colonies, and potential basking rocks, should be left intact.

22. Avoid siting wind energy facilities within 0.25 mile of identified habitat used by SGCN amphibians and reptiles.

23. Developers and their contractors should be instructed to follow posted speed limits to reduce, to the extent possible, collisions with all wildlife.

24. Where feasible, place power lines collecting electricity from turbines underground. Use recommendations of the APLIC (1994, 2006) for any required above-ground lines, transformers, or conductors.

25. Within wind generation project area boundaries avoid overhead power ~~or collector~~ line crossings of naturally occurring perennial streams, lakes, reservoirs, riparian corridors, and large (>5 acres) wetlands, where feasible.

26. When siting wind turbines within 2 miles of naturally occurring wetlands, riparian areas, lakes, reservoirs, and forested habitats collect adequate information to demonstrate that specific turbine locations will not result in significant levels of impacts to associated wildlife species and habitats. Determinations should be made on a project specific basis based upon site-specific data and information.

27. Use non-guyed non-lattice meteorological towers or attach bird diverters to guy wires on guyed met towers.[1]

28. In coordination with WGFD and USFWS, determine appropriate set-backs from ridges, bluffs or other features to avoid or minimize impacts to bats, neotropical birds, migratory birds or raptors. Determinations should be made on a project specific basis based upon site-specific data and information.

29. Minimize construction of all roads, fences and other ancillary facilities to reduce overall fragmentation; use bird diverters on fences with high potential for strikes within **0.6** miles of sage-grouse leks in core areas; 0.25 miles of sage-grouse leks in non-core areas and use or upgrade existing roads rather than constructing new roads where possible~~,~~ .

30. If sage-grouse mortality due to collisions with fences is documented implement appropriate actions to mitigate impacts.

31. Close access and maintenance roads to public travel except preexisting roads on public lands (as applicable to management purposes).

32. Access for hunting should continue within wind leases on public lands and on private land with landowner permission. Wind developers should not require indemnification from landowners who are willing to provide public access for hunting and fishing or from sportsmen and sportswomen who utilize the property.

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[1] Wyoming State Law requires all new and existing wind energy met towers to be mapped within the Wyoming Department of Transportation information system and marked to be visible from 2000 feet during daylights hours. This information is available to the aviation community on the Wyoming Department of Transportation website --http://gf.state.wy.us/METTowers/default.aspx.[1]

33. Adopt appropriate turbine design and siting standards to minimize bird and bat collisions (see U.S. Fish and Wildlife Service 2003: and DOI Wind Turbine Guideline Advisory Committee Recommendations 2010).

34. While still providing for site-security and workplace safety, applicants should comply with the DOI Wind Turbine Guideline Advisory Committee Recommendations (2010) regarding lighting where possible.

35. Developers should consult with existing landowners, WGFD, and the authorized land management agency to determine the location of new fences and what types of fence design and construction are appropriate based on the wildlife resource and needs of the existing landowner and/or land management agency.

36. At the completion of each project construction phase provide WGFD as-built maps of roads, turbine locations and ancillary project components in a GIS format.

37. Construction should be suspended within buffers and during the dates specified around raptor nests as provided in Appendix B and as updated by USFWS and WGFC.

38. Map and control noxious and invasive weeds within project area.

39. Developers are responsible (physically and financially) for monitoring and disposing of carcasses and handling/rehabilitation of injured wildlife on the project area. Developers are required to obtain the appropriate WGFD Chapter 10 and 33 permits and any USFWS requirements.

APPENDIX B
COORDINATION/CONSULTATION WITH PRIVATE LANDOWNERS & WIND DEVELOPERS, SITE SELECTION, BASELINE DATA COLLECTION & MONITORING RECOMMENDATIONS FOR WIND DEVELOPMENT, RECLAMATION, AND MITIGATION PRACTICES

COORDINATION/CONSULTATION WITH PRIVATE LANDOWNERS

Affected private landowners are an integral part of WGFD/Wind Developer consultations. "Affected landowners" are defined as any person, or their designated representative, holding record title to land on which any portion of a commercial facility generating electricity from wind is proposed to be constructed. The coordination/consultation process outlined below will include all wind generation facilities located on private lands including that portion of any collector system located on those same lands.

Prior to entering into any agreement with a wind energy developer to undertake studies or monitoring activities on private lands that precede efforts to develop a Conservation Plan, the WGFD shall request from the developer a written statement certifying that all affected landowners have been notified of the proposed studies or monitoring activities and have granted all necessary access for the purpose of such studies or monitoring.

Prior to entering into any substantive discussions with the WGFD regarding WGFD recommendations for wind energy development, but in no case less than six months prior to the submission of an application for development:

- WGFD shall request from the developer contact information for all affected landowners. WGFD will not meet with developers until a list of affected landowners has been provided by the developer.
- The WGFD shall notify affected landowners of all meetings between WGFD and the developer.
- Affected landowners or their representative shall be entitled to participate in all discussions between the developer and the WGFD.

Prior to submittal of any recommendations from the WGFD to the ISC and/or to local governments, the WGFD shall collaborate with the affected landowner(s) and the developer to develop a "Conservation Plan" for affected private lands incorporating mutually agreed upon goals and practices. In development of this Conservation Plan:

- Discussions shall be conducted in a collaborative manner.

- The parties may mutually agree to utilize a facilitator or to engage in mediation with such facilitator or mediator approved by all parties.
- The WGFD will designate a WGFD representative to the discussions who is mutually acceptable to the affected landowners and the WGFD.
- If the landowner and the developer have agreed to certain conservation measures prior to initiation of the collaboration required under this section, the WGFD shall accept these as components of the Conservation Plan or provide in writing the reasons for their rejection.
- The final Conservation Plan shall be signed by the developer, the affected landowners or their authorized representative and the Director of the WGFD.

- The Conservation Plan shall be incorporated into developer's Permit Application to ISC.
- The Conservation Plan shall become the WGFD "recommendations " under W. S. 35-12-110 (b) and (c) and the WGFD recommendations to any local government entity.
- The parties shall jointly advocate for ISC incorporation of the Conservation Plan into the developer's permit.

- A Conservation Plan shall not be binding on any party unless it has been signed by a majority of affected landowners or by landowners representing a majority of the affected private lands. A Conservation Plan shall be binding only on parties signatory to that Plan.

If any affected landowner or the project developer declines to participate in the Conservation Plan process or a Conservation Plan is not successfully developed and signed by the WGFD, an affected landowner or the project developer :

- WGFD shall provide contact information provided by the developer for all affected landowners to the ISC.
- The landowner, with or without the concurrence of the developer, may submit a conservation plan to the ISC.
- The WGFD may make recommendations to ISC as provided by statute as to lands not under a joint Conservation Plan.
- The process will proceed as outlined in the Industrial Development and Siting Act.

SITE SELECTION

Appropriate site selection for wind energy development is key in preventing negative impacts to wildlife. Therefore, detailed planning and survey efforts prior to investment and eventual construction will help identify and avoid problems that may occur, determine sites that are unsuitable for development, and minimize or mitigate impacts that cannot be avoided. In general, previously altered landscapes, such as cultivated, industrial, and urbanized areas with existing roads and power line corridors are, from a wildlife perspective, more fitting locations for wind development.

Our wind energy development recommendations are aimed at abiding by the following guiding principles.

1. Establish regulatory clarity and consistency while still providing adequate protection of Wyoming's wildlife resources.

2. Attain methodological consistency in the development of pre and post- construction monitoring requirements.

3. Develop monitoring protocols that are scientifically sound while establishing reasonable certainty about the direct and indirect effects of wind development on wildlife.

4. Maintain a degree of reasonable flexibility to accommodate the unique characteristics of each proposed wind development.

5. Facilitate effective communication between project proponents and WGFD while also complimenting other local, state, and federal wildlife-related regulatory processes without creating conflicting recommendations.

6. Acknowledge the consequences that would result from the addition of Greater Sage-grouse or any other species to the federal list of threatened or endangered species.

7. Establish a process to determine appropriate mitigation in the event that unforeseen wildlife conflicts arise during or after the construction of a wind energy development.

The following recommendations for baseline data collection and monitoring have been developed by WGFD staff to lessen future impacts to wildlife and facilitate planning for wind development. In all cases, baseline and monitoring data and reports will be provided to WGFD (Habitat Protection Office and appropriate Regional Office) on an annual basis. In addition, all research and monitoring design and results must be made available for review by the WGFD and in some instances may require independent peer review.

Consistent with the FAC Draft Guidelines (2010), WGFD offers a tiered approach to our review of wind development. We recommend that industry meet with WGFD very early in the process (pre-site selection, pre-planning) to best identify potential issues. We advise that initial discussion with WGFD begin at least 2 years prior to the submittal of any applications.

Tier 1- Site Selection

The objective of Tier 1 is to help the developer identify site(s) to consider or reject for wind development based on potential or known conflicts with wildlife resources. Questions to address under this tier include:

1. Are there species or habitat(s) of concern present on the site?

2. Does the landscape contain areas where development is precluded by law, regulation or policy?
3. Are there known crucial areas for wildlife such as hibernacula, winter ranges, migration corridors, or other vital/sensitive habitats?
4. Are there large areas of intact habitat with species where habitat impacts are a concern?
5. Using best available scientific information, has the potential presence of important species or crucial/vital habitat been documented?
6. Which SGCN or interest is likely to use the proposed site based upon known data?

Tier 2- Field Monitoring to Document Wildlife Conditions and Potentially Predict Project Impacts

The objective of Tier 2 is to identify site-specific conditions regarding wildlife species and habitats based on pre-construction monitoring. Questions include:

1. Does pre-construction monitoring indicate that SGCN are present on or likely to use the proposed site?
2. Does monitoring indicate the potential for adverse impacts on the wildlife species or habitat?
3. If adverse impacts are predicted to a species or habitat, can these impacts be avoided (preferable) or mitigated?
4. Is monitoring needed for construction and post-construction?

Tier 3- During and Post-Construction Monitoring

This Tier identifies impacts to species and habitats and can provide the basis for designing and implementing appropriate mitigation. Questions include:

1. What is the bird and bat fatality rate for the project?
2. Have sage-grouse lek counts changed?
3. Has raptor nesting and production been affected?
4. Has big game distribution on crucial ranges changed, and, if so, how and to what degree?
5. Has big game population parameters (recruitment rates, etc.) changed?
6. Has other species of interest distribution and habitats been altered?

BASELINE DATA COLLECTION AND MONITORING RECOMMENDATIONS

Bats

The following are general recommendations aimed at standardizing surveys to improve our understanding and provide guidance on collection of baseline data related to bat issues (e.g., causal factors, species susceptibility, distribution, abundance, and behavior). These recommendations were developed by WGFD and the Wyoming Bat Working Group (WYBWG) specifically to address survey standardization in Wyoming. If additional information on broader

objectives is required please consult survey recommendations in Hester and Grenier (2005). These recommendations are intended to provide specific details (e.g., timing, duration, equipment, etc.), yet remain flexible enough to provide managers with the ability to prescribe appropriate surveys (e.g., pre- and post-construction, etc.) across a broad range of project sites. A combination of multiple approaches (e.g., passive and active acoustic or passive acoustic and carcass searches, etc.) is recommended and survey strategies may vary by site. Please refer to the Survey Matrix (Table 1) for additional guidance. As bat survey methods advance the WGFD and WYBWG will evaluate new techniques and equipment for potential application in the state and revise these recommendations if new methods are appropriate.

In general, we recommend surveys be conducted for a minimum of 2 years prior to construction and 3 years post construction to be consistent with recommendations for other wildlife species (i.e., birds, sage-grouse and big game).

Habitat Evaluation

1. Objective – Identify and quantify existing bat habitats within a project site.

2. Rationale – The results can be used to identify potential roosting and foraging areas for bats within project sites to prioritize surveys and improve siting. The analysis can also be used to quantify changes in habitat.

3. Equipment – No specialized equipment is required, however, analysis is most easily completed using remote sensing techniques (e.g., aerial or satellite imagery) and GIS.

4. Application – A pre-construction evaluation should be completed by identifying potential foraging areas (i.e., Forest and Woodlands, Grasslands and Shrub-steppe, Riparian Corridors, and Water Features) and roosting areas (i.e., Rock Shelters, Forest and Woodlands, Riparian Corridors) within the project boundary. Please refer to "A Conservation Plan for Bats in Wyoming" (Hester and Grenier 2005) for additional information on habitats and associated bat species. Habitat can be evaluated either remotely (e.g., GIS) or using ground surveys. Delineate foraging and roosting habitats within the project site. If the pre-construction evaluation is done using remote sensing then field verification is also recommended. Compare proposed turbine siting data with the results of the habitat evaluation to identify potential conflict areas.

   A post-construction habitat evaluation is recommended following development of the project site. Compare pre- and post-construction habitat evaluations to quantify changes in habitats within the project site.

5. Analysis of Data – Total area and the percentage of each foraging and roosting habitat type present within the project area prior to construction should be reported.

Passive Acoustic Surveys

1. Objective – Identify and quantify bat species and relative abundance near the rotor sweep zone.

2. Rationale – Results can be used to identify bat species presence and describe bat behavior (e.g., spatial and temporal use, etc.) likely to occur near rotor sweep zone. Data can also be used as an index of relative abundance for this component of the project area. For passive acoustic survey recommendations that address broader objectives see Hester and Grenier (2005).

3. Equipment – There are many systems available for acoustic monitoring of bats (e.g., AnaBat, Pettersson D500x, Binary Acoustics, etc.). The AnaBat system is the only known acoustic monitoring system currently being used in Wyoming. If other systems are to be used please consult the WYBWG prior to data collection to ensure that survey equipment is compatible with survey objectives.

4. Application – Passive acoustic survey stations should be designed to collect bat calls at ≥ 50 m whenever possible to identify activity within the rotor sweep zone. Met Towers often provide an appropriate structure for this type of data collection. At least one acoustic unit, aimed away from the prevailing wind direction, per Met Tower should be utilized. A second unit, placed near the ground (e.g., < 5 m), can be used to quantify bat activity below the rotor sweep zone in areas that concentrate bat use (e.g., roosting or foraging areas, etc.).

   Units should be deployed between April 15 and October 15 and be programmed to begin data collection ½ hr prior to sunset and end data collection ½ hr after sunrise. Equipment should be calibrated annually and checked bi-monthly to ensure that units are properly functioning. Non-functioning equipment should be replaced immediately. Storage cards should be rotated bi-monthly for data analysis.

   The number of acoustic survey stations needed for a project will vary depending on the available bat habitat in the area. If few (e.g., ≤ 2) survey stations are used during the pre-construction survey period, then the data collection period may need to extend past two years to ensure that the data accurately reflect conditions (e.g., species diversity, temporal and spatial use, etc.) within the project area.

   Results from previous studies have demonstrated a high correlation between data collected using the above recommendations and project site conditions (e.g., species diversity, temporal and spatial use, etc.) despite constraints that each unit samples a small amount of area (Weller 2007, Collins and Jones 2009). Please refer to Weller (2007) for additional specifics regarding the deployment of passive units on met towers.

5. Analysis of Data –Analysis of bat calls should only be performed by experienced personnel. Species identification should be made whenever possible; however, calls should at a minimum be identified to a frequency grouping (e.g., 25 kHz, 40 kHz, etc.).

   For each unit deployed report the total number of calls, number of identifiable calls, total number of survey nights, number of species detected, scientific name of species detected, and number and identity of frequency groups detected (e.g., 25 kHz, 40 kHz, etc.). The index of activity should be reported as the total calls per survey night per unit. The

location (i.e., UTM), equipment aspect, microphone height, surveyor, and name of call analyst should also be reported.

A voucher call (i.e., representative call sequence) should be submitted for each species and frequency groups detected with the final report. The following supporting information should be supplied for each voucher call, location (i.e., UTM), date, time, scientific name of species detected, detector height and aspect, and name of call analyst.

Active Acoustic Surveys

1. Objective – Identify and quantify bat species presence below the rotor sweep zone.

2. Rationale – Results should be used primarily in conjunction with other survey methods (e.g., live capture). These types of surveys can be used to identify and prioritize additional survey locations, enhance identification of species (i.e., for those species that are not easily captured), and target areas that concentrate bat activity (e.g., foraging). For active acoustic survey recommendations that address broader objectives see Hester and Grenier (2005).

3. Equipment – The same equipment used for passive acoustic monitoring should be used for active acoustic monitoring. External display devices (e.g., laptops or PDA) can improve the observer's ability to collect high quality calls.

4. Application – Active acoustic monitoring should begin ½ hr before sunset and continue for at least 2½ hours. Personnel should attempt to follow bats in flight during the entire survey period. Care should be taken to collect long call sequences, whenever possible, to facilitate species identification. Avoid selecting survey sites near areas that reduce an observer's ability to hear bats (e.g., high ambient noise).

   Mobile (i.e., roaming or vehicle transects) acoustic surveys has the potential to quantify bat species and relative abundance below the rotor sweep zone across larger landscapes. This method collects bat calls while travelling a predetermined motorized route. There is no established methodology for this type of survey and individuals that are considering using this technique should consult qualified individuals before initiating surveys to ensure that the surveys are conducted in a robust manner to maximize inference.

5. Analysis of Data – Refer to Passive Acoustic Surveys – Analysis of Data.

Live Capture

1. Objective – Obtain demographic information (e.g., sex, age, reproductive status, etc.) of bats using near ground (< 20 m) habitats (i.e., below the rotor sweep zone) that cannot be obtained through acoustic monitoring.

2. Rationale – Results should be used primarily in conjunction with other survey methods (e.g., active acoustic). This type of survey can be used to prioritize additional surveys, enhance efforts to positively identify species that are hard to identify through acoustic monitoring, and target areas that concentrate bat activity (e.g., foraging areas). For live

capture survey recommendations that address broader objectives see Hester and Grenier (2005).

3. Equipment – A Chapter 33 Scientific Collection Permit is required by the Wyoming Game and Fish Department for live capture surveys. All individuals that will be handling bats should have their rabies prophylaxis. Mist nets and triple high mist nets are the most common equipment used for live capture of bats in Wyoming. The use of harp traps is more limited in Wyoming because of the high proportion of open landscapes. A more comprehensive discussion on additional equipment required for live captures can be found in Hester and Grenier (2005).

4. Application – Mist nets can be deployed successfully in almost any location where bats are expected to fly, and are highly effective for capturing bats at ground, sub-canopy, and canopy levels (i.e., below the rotor sweep zone). Identify productive sites by conducting acoustic surveys in advance. Capture success is usually highest near areas that concentrate use (e.g., water sources, foraging sites, and flyways [i.e., forest gaps, trails, and mountain ridges]).

   Surveys should be performed between June 1 and August 30. Each netting site that is identified in the project area should be surveyed at least 3 times during the field season. Nets should be set up ½ hour prior to sunset and be open for at least 2½ hours. Bats should only be processed by experienced individuals to reduce potential injury to bats. Please refer to Hester and Grenier (2005) for handling, holding, and processing bats in Wyoming.

5. Analysis of Data –For each survey occasion report the total number of bats captured, sex ratio, age ratio, site description, date, time, location, beginning and ending weather conditions, moon phase, time nets open/closed. Report also the mean catch per unit effort (i.e., number of bats captured per unit of survey time) for each site. For each bat captured species, sex, age, time of capture, ear length, forearm length, weight, reproductive status, and body condition should be reported.

Carcass Search

1. Objective – Identify and quantify bat species mortality after construction of turbines.

2. Rationale – The results of post-construction carcass searches are used to estimate mortality rates of bats at wind energy development sites.

3. Equipment – The WYBWG recommends searchers have their rabies prophylactic vaccination prior to conducting carcass searches to minimize risk associated with handling dead or wounded bats. A Chapter 33 Scientific Collection Permit is also required by the Wyoming Game and Fish Department for all personnel planning to collect bat carcasses.

4. Application – Carcass searches should be conducted weekly during two periods (Apr 15 – Jun 15) and (Aug 1 – Sept 30). More intensive carcass searches may be conducted if

necessary. We recommend that a subset of carcasses collected be submitted to the Wyoming Game and Fish Department as voucher specimens. Remaining carcasses (that likely remain attractive to scavengers) should be used to determine searcher efficiency and disappearance rates (Kerns 2005, Arnett et al. 2008). Carcass searches should be conducted in a robust method and estimates should correct for disappearance rates and searcher efficiency (Arnett et al. 2009, Baerwald et al. 2009).

5. Analysis of Data – Report age, sex, species, total number of killed and wounded bats found, and an estimate of bat mortality (Arnett et al. 2009, Baerwald et al. 2009). Reporting procedures for the Wyoming Game and Fish Department Chapter 33 Scientific Collection Permits must also be followed.

Table 1: The following matrix was developed by the Wyoming Bat Working Group to facilitate survey selection for bats within proposed wind project sites. The matrix recommends pre- and post-construction survey methods and identifies relevant actions (e.g., timing, permits, etc.) for conducting surveys in Wyoming.

Recommended Pre-Construction Survey Methods					
Survey Type	**Objectives**	**Timing**	**Permits[1]**	**Training**	**Comments**
Habitat Evaluation	Quantify existing habitat.	Anytime	None		
Passive Acoustic	Quantify bat activity in the rotor sweep area.	April 15 – October 15	None	Call interpretation	Provide copies of calls to WGFD/WYNDD[2]/Lead Agency.
Active Acoustic	Supplemental information for live capture and passive acoustic.	June 1 – August 31	None	Call interpretation	Provide copies of calls to WGFD/WYNDD/Lead Agency.
Live Capture	Collect demographic information on bats	June 1 – August 31	Chapter 33	Bat handling and identification.	Provide copies of calls to WGFD/WYNDD/Lead Agency.
Recommended Post-Construction Survey Methods					
Survey Type	**Objectives**	**Timing**	**Permits[1]**	**Training**	**Comments**
Habitat Evaluation	Quantify changes in habitat	Anytime	None		
Passive Acoustic	Quantify bat activity in the rotor sweep area	April 15 – October 15	None	Call interpretation	Provide copies of calls to WGFD/WYNDD/Lead Agency.
Carcass Search	Quantify bat species that are being impacted.	April 15 – June15 August 1 – September 30	Chapter 33		Provide some specimens

[1] - Some federal land management agencies require permits for performing surveys. Please coordinate with the appropriate agency to ensure regulatory compliance.

[2] Wyoming Natural Diversity Database

Passerines and Raptors

Each proposed wind energy project is site-specific with local differences in avian species present, season and type of use, habitat, topography, weather patterns, and site development potential. Appropriate site selection for wind energy development is key in preventing negative impacts to birds. In addition, planning a wildlife-friendly wind energy development can lower long-term costs and potential liabilities under Federal wildlife protection laws, such as the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, and the Endangered Species Act. Therefore, detailed planning and survey efforts prior to construction will identify problems that may occur, how to circumvent these problems, how to mitigate problems that cannot be avoided, and identify sites that are unsuitable for development. We encourage developers to meet as soon as possible with the USFWS to get their input relating to potential impacts to migratory birds and raptors.

We recommend the following monitoring recommendations for pre-, during, and post-construction should be implemented when wind energy projects are proposed for or occur in areas occupied by breeding, foraging, and migrating birds, especially Species of Greatest Conservation Need. These should serve as a starting point until the Wyoming Partners In Flight Bird Conservation Plan update has been completed, which will include a more comprehensive set of best management practices and recommendations for siting, monitoring, mitigation, and research to minimize the impacts of wind energy development on birds.

In general, we recommend surveys be conducted for a minimum of 2 years prior to construction and a minimum of 3 years post-construction to be consistent with recommendations for other wildlife species (i.e., bats, sage-grouse and big game).

1. Perform a risk assessment reconnaissance survey that includes a review of existing wildlife databases, maps, literature, reports, and aerial photographs, as well as discussions with wildlife experts, to determine concerns and potential conflicts with birds occurring in the proposed development area. Results may indicate that certain sites are unsuitable for wind energy or that the size of the project may need to be scaled back.
2. Until a sufficient body of scientific research is developed nationwide to determine acceptable certainty regarding the level of disturbance or displacement of birds due to wind energy developments in general, wind project proponents are expected to implement appropriate monitoring to help answer this question on a case-by-case basis in Wyoming.
3. We recommend conducting pre-construction surveys within the project area and within 1 mile of the project boundary using the techniques described below. Data should document the species and number of birds observed, their movements and distribution, the proportion of birds occurring within the rotor sweep area, and altitude and orientation of flight during various weather conditions.

Point Counts

a) Conduct spring and autumn point- count surveys to detect resident and migrant passerines, and other localized birds. Fixed-radius point count surveys (Reynolds et al. 1980) should be conducted weekly over a 12-week period in spring and

again in fall in order to detect early, mid, and late migrants. Point count surveys should begin in April to late June (depending on location and elevation) to detect breeding songbirds. Points should be randomly distributed across the proposal area or strategically placed to assess data at turbine locations (depending on the proposed development design). A sufficient number of points should be incorporated in the design to enable statistical power in the analyses. Surveys should begin ½ hour before official sunrise and end approximately 4 to 5 hours after official sunrise (USGS 1998) for breeding birds; and occur at other times during the day for other birds. UTM coordinates of the count site, number of birds detected, time, and species should be recorded. Surveys should be conducted for 20 minutes at each point to optimize surveying time and number of stations (points) in the survey (Reynolds et al. 1980). Sufficient distance between point count stations should be considered to avoid duplication of counts (Alldredge et al. 2006, Buckland et al. 2009).

b) Winter surveys- A minimum of 2 surveys should be conducted per season: early winter from 1 December – 15 January and late winter from 16 January – 28 February. Follow point count protocol. Species, number of birds detected, time, primary habitat, and UTM coordinates of each sighting should be recorded.

c) Depending upon survey results, additional surveys for sensitive avian species (e.g. SGCN) present within sensitive habitats (e.g. wetlands, riparian areas) may be suggested. Survey methodology will depend on the species present.

Raptors

a) We recommend one day-long survey for raptors should occur each week during both the spring and autumn 12-week period of bird point counts. UTM coordinates of the count site, location relative to the project, number of birds detected, sex and age class (if possible), time, species, behavior, altitude, flight direction, and primary habitat should be recorded. Any observations of large flocks of non-raptors (waterfowl, shorebirds, swallows, cranes, etc.) should also be recorded.

b) We recommend area search surveys occur during the breeding season to locate raptor nests. Surveys to locate raptor nest structures within suitable habitat (trees, rock outcrops, hillsides, etc.) can be conducted either aerially in a low-flying fixed-wing aircraft or helicopter, or on foot along transects that are no more that ½ mile apart (depending on topography and physical features) or by driving along public roads and accessible private roads that are within 1.0 miles of the project area. In general, the method used will depend on the size and accessibility of the proposed project site. However, if ground surveys cannot provide comprehensive coverage and accurate locations of nests within the project area, aerial surveys should be implemented. UTM coordinates, nesting substrate, status (occupied, unoccupied, incubating adult, young in the nest), and primary habitat should be recorded for each nest located. See the Table 2 for species-specific survey dates.

Carcass Search and Collection

a) Conduct carcass collection surveys for the duration of post-construction monitoring; typically 3 years (appropriate state and federal permits are required

for carcass salvage). The extent (e.g. sub-sample versus complete sample of developed area), frequency (e.g. daily, weekly, biweekly), and seasonality (e.g. migration, breeding season) should be determined prior to the initiation of the surveys and will be influenced by site-specific characteristics such as terrain and vegetation type, bird population levels, size of the development, and the level of impact the development has on birds in the area. All carcasses should be collected and identified. Annual fatality rates per MW or per turbine should be estimated. Actual fatality rates at wind turbines are incompletely observed and must be adjusted by at least these two factors: carcass removal by scavengers and searcher efficiency rates. Scavenger removal trials should be conducted at each site to determine the length of time it takes scavengers to find and remove carcasses. This rate can then be factored into statistical estimations of fatality rates to provide more accurate estimates (for protocols see Smallwood 2007).

b) Searcher efficiency trials should be conducted at each site to account for differences in vegetation and individual detection rates. This rate can then be factored into statistical estimations of fatality rates to provide more accurate estimates (for protocols see Kunz et al. 2007).

Table 2: Diurnal Raptor Survey Dates (2a) and Disturbance Free Dates (2b)

Species	March			April			May			June			July			August		
	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31	1	15	30
American Kestrel																		
Bald Eagle																		
Cooper's Hawk																		
Ferruginous Hawk																		
Golden Eagle																		
Merlin																		
Northern Goshawk																		
Northern Harrier																		
Osprey																		
Peregrine Falcon																		
Prairie Falcon																		
Red-tailed Hawk																		
Sharp-shinned Hawk																		
Swainson's Hawk																		

Darkened block indicates best times to detect birds in courtship (early dates) or with young in the nest when adults will be conspicuous (later dates). For accipters, Merlins, and Peregrine Falcons, detectability during courtship is variable, with some pairs almost impossible to detect.

…….. : Indicates periods for species with conspicuous nests during which surveys can also be conducted effectively.

Note: Dates may vary slightly by latitude, altitude or other factors affecting phonology and should be adjusted depending on field conditions.

Table 2b: continued

WGFD DISTURBANCE-FREE DATES AND BUFFERS FOR RAPTORS		
SPECIES	**DISTURBANCE-FREE DATES**	**DISTURBANCE-FREE BUFFER**
Bald Eagle	February 15 – August 15	½ mile
Ferruginous Hawk	March 1 – July 31	1 mile
Golden Eagle	January 15 – July 31	½ mile
Merlin	April 1 – August 15	½ mile
Northern Goshawk	April 1 – August 15	½ mile
Peregrine Falcon	March 15 – August 15	½ mile
Prairie Falcon	March 1 – August 15	½ mile

Note: Disturbance-free dates include territory establishment through fledging.
Note: Additional considerations include line of sight, visibility, type of disturbance activity, location of disturbance above or below the occupied nest, and specific situations.

Sage-Grouse

The WGFD has provided the WGFC with a summary of the current understanding of potential impacts of wind development on sage-grouse. While much additional research needs to be conducted, the WGFD has concluded that the best information currently available indicates a risk of significant population level impacts to sage-grouse if wind development occurs in a sage-grouse core area. In addition, the U.S. Fish and Wildlife Service has notified the WGFD (letter dated July 7, 2009 from Brian Kelly to Director Ferrell), that "constructing wind farms in core areas, even for research purposes, prior to demonstrating that it can be done with no impact to sage-grouse, negates the usefulness of the core area concept as a conservation strategy and brings into question whether adequate regulatory mechanisms are in place to protect the species." Having regulatory mechanisms is a key factor used by the USFWS in determining whether a species should be listed as endangered or threatened. The WGFD interprets the USFWS letter as a clear signal that state authorization of wind development in a sage-grouse core area, without clear demonstration from the project proponent that the activity will not cause a decline in sage-grouse populations, leaves the state in a precarious position to demonstrate that adequate regulatory mechanisms are in place to conserve sage-grouse.

Based on our current understanding of potential conflicts between sage-grouse and wind development, the WGFC directed the WGFD to recommend to the WISC that no wind turbines be constructed in sage-grouse core area without clear demonstration from the project proponent that the activity will not cause a decline in sage-grouse populations. W.S. 35-12-110(c) allows WGFD to recommend appropriate conditions that might be included in the Industrial Siting Permit. The WGFC has directed the WGFD to continue to explore, through research outside of sage-grouse core areas, what impacts will occur to sage-grouse from wind energy development. That research may result in future revisions to these recommendations and WGFC policies.

The following recommendations for wind development projects in regard to sage-grouse baseline data collection and monitoring should occur assuming a multi-state industry supported research program is operational to determine sage-grouse response and population performance to wind development. If the research program is not operational additional research actions will be recommended for individual projects. Research response variables should include population

and habitat parameters such as nesting success, chick survival, lek attendance, and any changes in distribution, movements, and habitat use.

For projects that will occur outside a sage-grouse core area we recommend the following monitoring protocol:

- Conduct lek counts (using WGFD protocol) within a 2 mile buffer of the proposed project area boundary.
- Map habitat within a 2 mile buffer area of the project boundary.
- Compare lek counts with a suitable nearby reference area.
- We recommend 2 years pre-construction data collection followed by 3 years post construction with annual review thereafter as determined by the assigned Technical Advisory Committee (TAC).

Big Game

The following baseline data and monitoring recommendations for wind development projects in regard to big game should occur assuming a multi-state industry supported research program is developed that measures big game responses to wind development. If the research program is not operational additional research actions will be recommended. Research response variables should include population and habitat parameters such as fawning/calving rates, neonate survival, and any changes in distribution, movements, and habitat use.

If the project occurs on lands designated as crucial winter range, identified parturition areas, or will bisect known migration corridors, we recommend the following to provide baseline data and post-development data that will help identify any associated impacts and provide for future mitigation options for affected big game species:

- Radio collar a representative sample (to be determined in coordination with WGFD) of the female portion of the affected herd(s).
- Collect telemetry relocation data 2 years prior to development and 3 years post development to determine habitat use, identify migration corridors, and identify changes in habitat use and population demographics.
- Collect and compare these parameters on a suitable nearby reference area.

These data should be collected, analyzed, and provided in an annual report to WGFD. At the end of three years, if it is determined that significant avoidance of important habitats is occurring or population parameters are being negatively affected by the wind energy development, a mitigation plan should be developed in collaboration with WGFD to compensate for that impact.

Amphibians

In general, we recommend baseline monitoring be accomplished through incidental observations while performing other wildlife surveys. Incidental observations will allow for trend data, which could elucidate possible shifts in species assemblages resulting from energy development. In addition to generalized incidental monitoring, surveys may be recommended on specific SGCN.

SGCNs include the following species: boreal toad, Wyoming toad, wood frog, Columbia spotted frog, Great Basin spadefoot, plains spadefoot and northern leopard frog. Additional information on these species can be found in Table 3.

If no SGCN is known to occur within or near a wind development project, we recommend that incidental observations be recorded for amphibian species. All amphibians encountered incidentally during wildlife surveys should be documented. Species, geographic coordinates (preferably decimal degrees or UTM), date, age class (adult, juvenile, larval, or egg), general vegetation type, and general comments are requested for each observation. Observations will be collected while performing other wildlife surveys within the study area. We recommend that 2 years of preconstruction monitoring and 3 years post construction monitoring be completed. A two year preconstruction time frame helps ensure that surveys can be conducted in a wide range of environmental conditions. Many species that are rare or cryptic may easily be overlooked with only one year of survey. If a SGCN is discovered during the incidental observations additional monitoring may be recommended (Figure 1).

<u>Species of Greatest Conservation Need (SGCN)</u>

If a SGCN is known to occur or has the potential to occur within or near a wind development project, additional monitoring is recommended (Figure 1).

- The monitoring of SGCNs starts with creating habitat maps for a wind development project. In conjunction with mapping terrestrial habitats, the following water features will also be mapped: ephemeral drainages, perennial waters, vernal pools and playas.

- If amphibian habitat is not found during mapping, no additional monitoring will be needed. However, incidental monitoring is recommended.

- However, if SGCN amphibian habitat is found, we recommend the project developer contact the Department to discuss if the project can be designed so that amphibian habitat can be avoided. To protect SGCN amphibian habitat, the Department recommends a 500 meter buffer. This buffer was designed to incorporate SGCN average home range and migration distances (Hammerson 1999, Ernst and Ernst 2003, Werner et al. 2004, Lannoo 2005, Parker and Anderson 2007). If the project is designed such that habitat disturbance is located greater than 500 meters from water features, including ephemeral drainages, perennial waters, vernal pools and playas additional monitoring will not be needed. However, incidental monitoring is recommended.

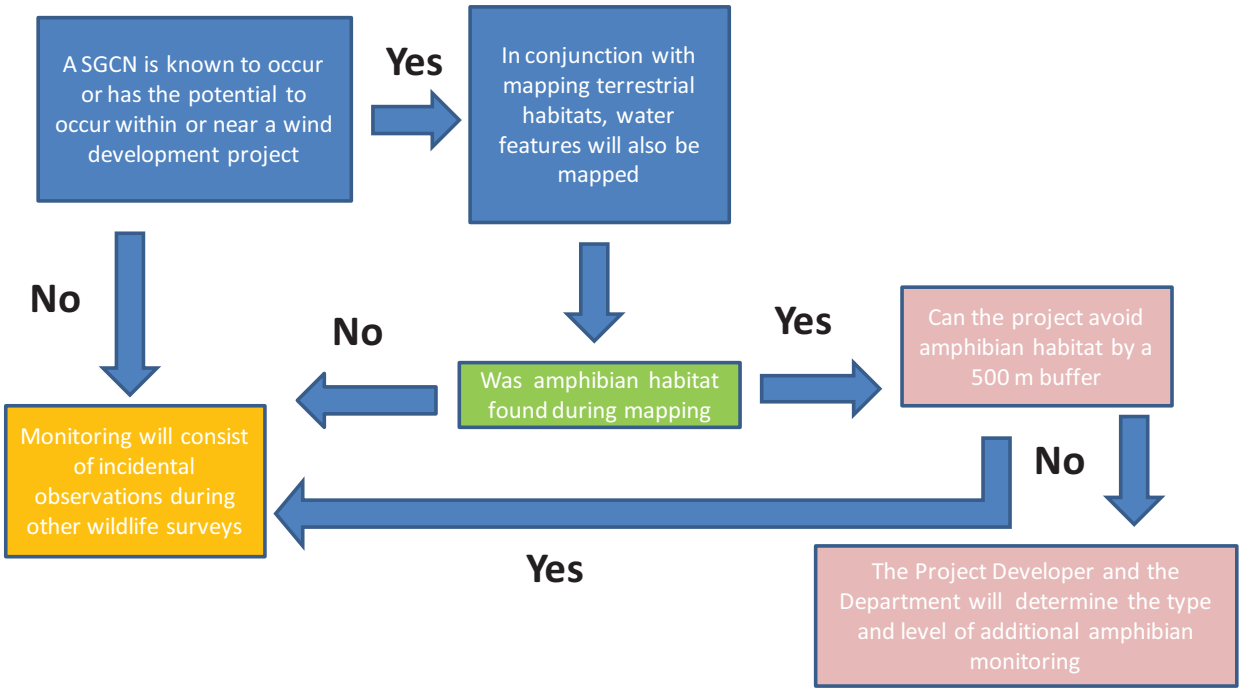
- If SGCN amphibian habitat cannot be avoided, the project developer and the Department will determine the type and level of additional amphibian monitoring needed.

- Because of breeding chronology and the secretive nature of some species, two years of survey are recommended before development begins. During predevelopment surveys, important amphibian areas (such as breeding sites) should be designated for avoidance during construction. Surveys should be conducted at least three years post-construction to determine possible effects of development on amphibian species.

- Mitigation may be recommended if sensitive habitats or species are impacted.

- Reclamation plans of disturbed habitat sites for these species should be developed.

Figure 1. Decision Tree for Amphibian Monitoring Recommendations Associated with Wind Energy Development



Reptiles

If no SGCN is known to occur within or near a wind development project, we recommend that incidental observations be recorded for reptile species. All reptiles encountered incidentally during wildlife surveys should be documented. Species, geographic coordinates (preferably decimal degrees or UTM), date, age class (adult, or juvenile), general vegetation type, and general comments are requested for each observation. Observations will be collected while performing other wildlife surveys within the study area. We recommend that 2 years of preconstruction monitoring and 3 years post construction monitoring be completed. A two year preconstruction time frame helps ensure that surveys can be conducted in a wide range of environmental conditions. Many species that are rare or cryptic may easily be overlooked with only one year of survey. If a SGCN is discovered during the incidental observations additional monitoring may be recommended (Figure 2.)

There are three reptile SGCN; midget faded rattlesnake, northern tree lizard, and Great Basin gophersnake. All three species occur in southwest Wyoming. Additional information on these species can be found in Table 3. If a wind project is located in habitat that is known to have these species or has the potential to occur within or near the project, additional monitoring is recommended.

- If reptile habitat, hibernacula and potential hibernacula habitat is not found during two years of preconstruction monitoring, no additional monitoring will be needed. However, incidental monitoring is recommended.

- However, if SGCN reptile habitat is found, we recommend the project developer contact the Department to discuss if the project can be designed so that reptile habitat can be avoided. To protect SGCN reptile habitat, hibernacula and potential hibernacula habitat, the Department recommends a 500 meter buffer. This buffer was designed to incorporate SGCN average home range and migration distances (Ernst and Ernst 2003, Hammerson 1999, Lannoo 2005, Parker and Anderson 2007, Werner et al. 2004). If the project is designed such that habitat disturbance is located greater than 500 meters from hibernacula or potential hibernacula habitat additional monitoring will not be needed. However, incidental monitoring is recommended.

- If SGCN reptile habitat, hibernacula and potential hibernacula habitat cannot be avoided, an additional three years post construction monitoring is recommended.

- Mitigation may be recommended if sensitive habitats or species are impacted.

Midget Faded Rattlesnake, Great Basin Gophersnake, and Northern Tree Lizard Survey Protocol - Design of Survey

1. We recommend that before a survey is done, that the survey team spend a day with Wyoming Game and Fish personnel to ensure that the survey method is being used correctly.

2. Delineate rock outcroppings with a Southern aspect (SE, S, SW or 120°- 240°) using aerial photography, Google Earth, or other available GIS data layers within the proposed project area. Any rock outcropping above 7,500 feet or with a Northern aspect may be excluded from the survey design. Although hibernacula for these species are historically observed below 7,000 feet, it would be prudent to search slightly higher elevations to ensure the absence of midget faded rattlesnake, Great Basin gophersnake, or northern tree lizard populations. The proposed elevation would help prevent the possible exclusion of males migrating away from hibernacula during summer months, or other fringe hibernacula.

3. A total of three surveys should be performed from late spring through early fall (mid May through mid September) on delineated rock outcroppings. Surveys can only be performed when daytime temperatures exceed 55°F for a week or more. At least two surveys should be conducted between July 15th and September 15$^{th.}$ Surveys may be performed in spring and fall months at any time during the day. However, during summer months when daytime temperatures exceed 85°F, surveys should be limited to morning and early afternoon time periods (8:30AM to 1:00PM).

4. Each delineated rock outcropping should be surveyed for a total of 1 man-hour per km^2 of suitable habitat (i.e. One person should survey suitable habitat for 1 hour, while two people could survey the same area for 30 minutes). For midget faded rattlesnakes, it is recommended that surveyors wear protective gear or clothing while conducting surveys to maintain safety. This could include any one of the following items: snake boots, snake gaiters, or snake chaps. When climbing rocks, surveyors should also verify that all handholds snake free. Observers should listen closely for snakes rattling while conducting the survey. Some snakes will not be easily observable, and may give their locations away by this behavior. Effort should be made to avoid flipping rocks. This activity could alter reptile habitat. Surveyors are recommended to inspect crevices, fissures, and overhangs within rock outcrops. All herpetafauna found during the course of a survey should be noted on observational datasheets and photographed.

   Upon observation of a reptile or identifiable shed skin, the surveyor should fill out the correct datasheet and collect a photo voucher of the specimen. A GPS point (UTM NAD 83 zone12) should be taken at the observed location. Effort should be made to not disturb the observed reptile.

Figure 2. Decision Tree for Reptile Monitoring Recommendations Associated with Wind Energy Development

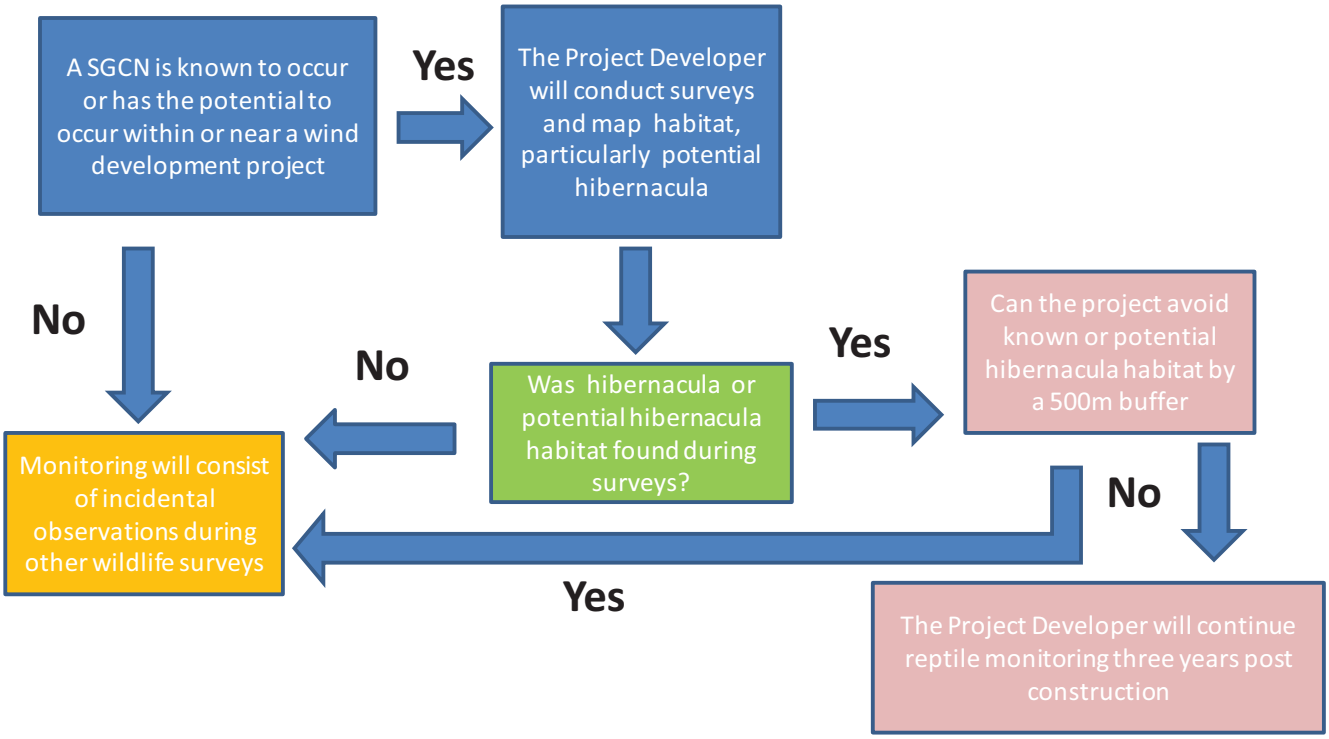


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Table 3: Amphibians and Reptiles – SGCN 2005 Species Specific Monitoring

Amphibians and Reptiles which will need species specific monitoring	SGCN Rank 2005	Habitat	Range
Boreal Toad	NSS1	Wet situations in the foothills, montane and subalpine life zones. Seldom found far from water	Mountains west of Continental Divide, Medicine Bow Mountains
Wyoming Toad	NSS1	Floodplains, ponds, small seepage lakes in the shortgrass communities of the Laramie Basin	Laramie Basin. Only known wild populations near Centennial, WY
Northern Tree Lizard	NSS2	Rocky Cliffs in sagebrush desert	Upper Green-Flaming Gorge Watershed
Midget Faded Rattlesnake	NSS2	Sagebrush communities and rocky outcrops	SW Wyoming with population focused near the towns of Green River and Rock Springs.
Wood Frog	NSS3	Beaver ponds, streams, and lakes in montane zones.	Medicine Bow and Bighorn Mountains
Great Basin Gophersnake	NSS2	Sagebrush communities and desert habitats	SW Wyoming
Columbia Spotted Frog	NSS4	Ponds, sloughs, and streams in the foot hills and montane zones	Mountains west of Continental Divide, Bighorn Mountains

Table 3: Continued

Amphibians and Reptiles which will need species specific monitoring	SGCN Rank 2005	Habitat	Range
Great Basin Spadefoot	NSS4	Sagebrush communities mostly in the Wyoming Basin and Green River Valley	Low elevations mainly west of Continental Divide
Plains Spadefoot	NSS4	Grasslands and sagebrush communities in the plains zones	Low elevations mainly east of Continental Divide
Ornate Box Turtle	NSS4	Sandy open grasslands	Along Lower North Platte adjacent to Nebraska
Northern Leopard Frog	NSS4	Permanent water in the plains, foothills, and montane zones. Prefers marshes and beaver ponds.	Statewide

* All species are considered SGCN.

Species Information from Baxter and Stone 1985.

Aquatics

The WGFD recognizes that proposed wind projects will differ in their potential for impacting stream channels and aquatic species. A one-size-fits-all approach to aquatic and geomorphology impact avoidance or monitoring would not adequately address the variability of each project or its location. Impact potential depends on elevation, aspect, slope, project size, soil type, vegetative cover, road density, distance from ephemeral or permanent water sources, and the presence of other (non-wind energy related) soil perturbations in the watershed. The approach described below is recommended to help wind development proponents identify the potential for sediment impacts to aquatic habitats, address that potential during project development, and monitor for impacts in cases where aquatic resources may be in jeopardy. Based on site-specific conditions the monitoring of culverts, roads with 5% slope or greater and geomorphological studies of waterways may be recommended.

The purpose of monitoring culverts and roads with 5% or greater slope is to determine the presence, absence and/or extent of cumulative impacts resulting from changes to the upland surface hydrology, erosion and deposition, to ensure that culverts are functioning as designed and are being maintained and to ensure that the long-term BMPs that were installed are still functioning and are being maintained.

The purpose of geomorphological monitoring activities is to determine the presence, absence and/or extent of cumulative impacts resulting from changes to upland surface hydrology, erosion and deposition and the potential for impacting habitats important to fish, macroinvertebrates, reptiles and amphibians. The geomorphological monitoring WGFD is recommending follows the Watershed Assessment of River Stability and Sediment Supply (WARSSS) methodology outlined in Rosgen (2006). The following descriptions of the WARSSS methodology are quotes from Rosgen (2006) and are provided here as background information:

Watershed Assessment of River Stability and Sediment Supply (WARSSS) is a geomorphology-based procedure for quantifying the effects of land uses on sediment relations and channel stability (Pg. 1-1).

WARSSS identifies the hillslope, hydrologic and channel processes responsible for significant changes in erosion, sedimentation and related stream channel instability. It uses a three-phase assessment process to quickly separate areas into low-, moderate- and high-risk landscapes and / or river reaches (Pg. 1-2).

The results of the WARSSS assessment reveal significant, adverse influences of land uses on stream channel stability, sediment sources and sediment yield that may affect the material beneficial uses of rivers and streams. WARSSS data can be used for watershed planning, “clean sediment” Total Maximum Daily Load (TMDL) assessments for non-point source pollution and stability analysis for river restoration (Pg. 1-2).

The Reconnaissance Level Assessment (RLA) is the first and most general phase of the three WARSSS assessment phases. It provides a broad overview of the landscape while focusing on

processes that may affect sediment supply and channel stability (Pg. 3-1). Performing a Reconnaissance Level Assessment (RLA) requires one to a few office days.

Sensitive landscapes, potentially unstable stream systems and sediment-generating land use activities need to be identified, prioritized and evaluated for potential impacts at a level of detail beyond the initial RLA analysis. The Rapid Resource Inventory for Sediment and Stability Consequence (RRISSC) provides this finer level of analysis (Pg. 4-1). Performing the Rapid Resource Inventory for Sediment and Stability Consequence requires about 1 week depending on data availability.

The Prediction Level Assessment (PLA), the most detailed level of the WARSSS methodology, is reserved for sub-watersheds and river reaches previously identified as being at high risk for sediment and / or river stability problems. The PLA compares direction, rate, nature and extent of departure of existing sediment and channel stability to a reference condition typical of stable, natural land and stream conditions (Pg. 5-1). Performing a PLA, would require at least 4 sampling occasions/reaches (before/after project implementation, upstream/downstream of project area).

A Rosgen Level II assessment consists of a morphological description of stream channel conditions at a reach. A Level III is synonymous with the PLA and includes all the aspects of a Level II assessment plus assessments of river stability, bank erosion, sediment competence, and sediment transport capacity.

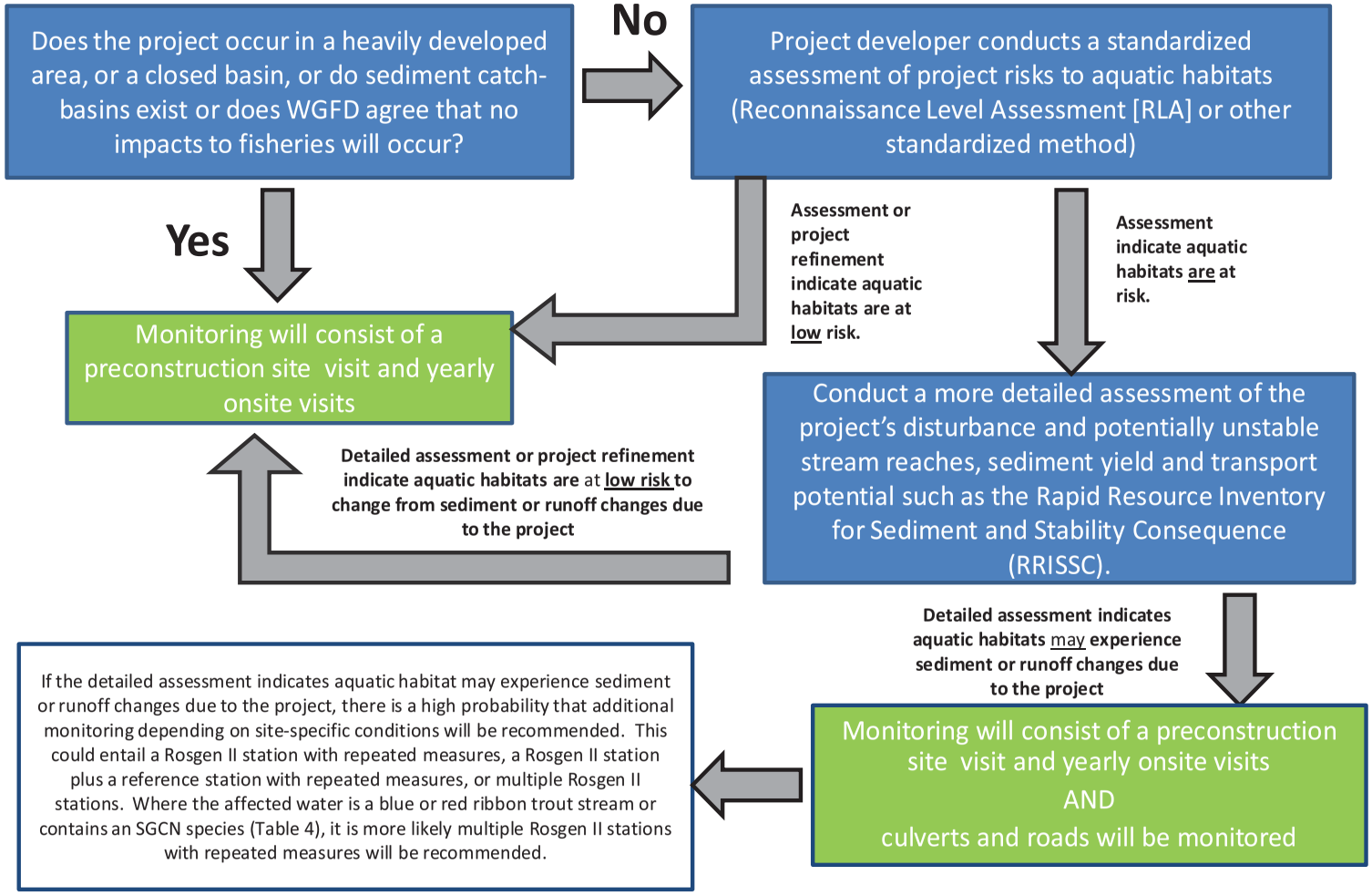
Recommended Approach

To identify and avoid impacts to aquatic resources, a multiphase approach is recommended (Figure 3). The approach includes varying levels of effort and assurance of impact avoidance depending on the apparent risk to aquatic habitats.

As indicated in Figure 3, very minimal effort is recommended if the wind project is proposed within an existing heavily developed area (e.g. an existing oil or gas field), is located within a closed basin (i.e. water cannot reach a perennial water body), or if sediment catchments exist on the ephemeral drainage(s) such that sediment could never reach a permanent water course, or the project developer and the Department agree that no impacts to a fisheries will occur. In these cases, WGFD recommends simply a pre-construction onsite visit followed by yearly onsite visits (Figure 3). The purpose of the yearly onsite visits is to ensure that the BMPs, as outlined in the Storm Water Prevention Plan, are working as designed. If problem/s are occurring, WGFD will provide recommendations to fix the problem/s. If the problem/s is not fixed in a timely manner, WGFD may recommend additional monitoring be conducted. Such yearly site visits are recommended for all wind energy developments.

Figure 3. Decision Tree for WGFD Aquatic Monitoring Recommendations

This decision tree will be used to develop wind energy recommendations to the ISC . The suggested assessments Reconnaissance Level Assesment (RLA) and Rapid Resource Inventory for Sediment and Stability Consequence (RRISC) and monitoring approaches are from Rosgen, D. 2006, Watershed Assessment of River Stability and Sediment Supply (WARSSS).



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- If the project proponent cannot demonstrate the proposed development is within an existing heavily developed area (e.g. an existing oil or gas field), is in a closed basin, or has substantial sediment basins, the WGFD recommends the project proponent conduct a standardized assessment to identify low, medium, and high risk landscapes and/or stream reaches (via a Reconnaissance Level Assessment [RLA] preferably or other standardized method to determine where critical areas exist down slope from a proposed project site (Figure 3).

- If the reconnaissance assessment indicates **low risk** to stream reaches or project refinements are implemented so that aquatic habitats **are at low risk**, monitoring will consist of a preconstruction site visit and yearly onsite visits (Figure 3). Examples of project refinements are: additional BMP's that will prevent the movement of sediment into nearby waterways; avoidance/minimization measures, such as larger road offsets from channels; implementation of measures to mimic existing surface water runoff patterns; or site-specific engineering controls.

- If the assessment indicates aquatic habitats **are at risk**, we recommend a more detailed assessment of the project's disturbance and potentially unstable stream reaches, sediment yield and transport potential such as the Rapid Resource Inventory for Sediment and Stability Consequence (RRISSC) be conducted (Figure 3).

- If the detailed assessment indicates **low risk** to change from sediment or runoff changes due to the project or project refinements are implemented so that aquatic habitats **are at low risk**, monitoring will consist of a preconstruction site visit and yearly onsite visits (Figure 3). Examples of project refinements are: additional BMP's that will prevent the movement of sediment into nearby waterways; avoidance/minimization measures, such as larger road offsets from channels; implementation of measures to mimic existing surface water runoff patterns; or site-specific engineering controls

- If the detailed assessment indicates that aquatic habitats **may experience sediment or runoff changes** due to the project, then monitoring will consist of a preconstruction site visit, yearly onsite visits and culverts and roads will be monitored (Figure 3). There is a high probability that additional monitoring depending on site-specific conditions will be recommended (Figure 3). This could entail a Rosgen II station with repeated measures, a Rosgen II station plus a reference station with repeated measures, or multiple Rosgen II stations. Where the affected water is a blue or red ribbon trout stream or contains an SGCN species (Table 4), it is more likely multiple Rosgen II stations with repeated measures will be recommended.

Detailed Culvert, Road And Channel Monitoring Recommendations
Culverts

If a perennial stream is crossed as a result of a wind development project, stream crossings by roads should be adequately designed to allow fish passage at all flows. Crossing types in order of descending desirability to minimize aquatic impacts are a) bridge spans with abutments on banks, b) bridge spans with center support, c) open bottomed box culverts and d) round culverts with the bottom placed no less than one foot below the existing stream grade. Some level of monitoring may be recommended. The level of monitoring will be determined by what type of structure is used to cross the perennial stream. If the stream is crossed either with a properly designed bridge or bottomless culvert, monitoring will consist of a preconstruction onsite visit with yearly onsite visits. If a round culvert is used, we recommend that data from two Rosgen II stations (above and below culvert) be collected.

Perched culverts block fish passage and in most cases are unacceptable in any stream that supports a fishery. A perched culvert may be acceptable and recommended by the Department to protect an upstream fishery population i.e. cutthroat trout population or native non-game population.

The following are recommended references for the minimum guidelines for culvert sizing and placement: the BLM's Gold Book or the Forest Service Handbook 7709.56b.

1. Collect GPS coordinates or other location specific information for each culvert site
2. Collect pre-construction photographs of the planned culvert site; upstream and downstream
3. Collect construction photographs of the planned culvert site following construction phase roadway installation (temporary width) and following final roadway installation (permanent width).
4. Typical SWPPP monitoring and maintenance requirements will apply during construction phase of the project.
5. Collect post-construction photographs of the culvert site; upstream and downstream.
6. Following completion of final roadway and shoulder installation (permanent width), place a graduated fence post upstream and downstream of each culvert. The posts should have visible markings every 2" to provide a visual reference within each photograph. Fence posts should be placed within 50 feet of the culvert openings. Posts should be placed outside of the channel flow so they are not directly affected by storm flow events. Each fence post location will be referenced by GPS or other location specific information.
7. GPS or otherwise identify the site where photographs will be taken for the upstream and downstream view.
8. Following completion of final roadway and shoulder installation (permanent width), culverts and accompanying fence posts will be monitored/photographed a minimum two times a year (spring after snow melt and fall). We recommend that

the fall monitoring occur before September 15, so there will be sufficient time to review the photographs and remedy any problems before winter. Additional monitoring is recommended after a summer rainfall event/s accumulating greater than ½ inch of precipitation in an hour as measured at the nearest National Weather Service Monitoring point (if within 10 miles of the site) or at the Facility operations and maintenance building.

9. Make photographs available for WGFD review within 30 days.
10. Monitoring will continue for two-years post SWPPP release, and will be re-evaluated by Project Developer and WGFD for necessity following that period.
11. If monitoring shows that impacts are occurring, WGFD and the project developer will meet to discuss what corrective actions need to be taken to remedy the cause of the impact. If impacts are still occurring, additional monitoring maybe recommended.

If the photographs reveal observable changes from erosion or deposition, consultation between WGFD and Project Developer will occur within 30 days after WGFD receives the photographs.

<u>Roads with 5% or greater slope</u>

1. Collect GPS coordinates or other location specific information for each 5% roadway slope monitoring point
2. Collect pre-construction photographs of each 5% roadway slope monitoring site; upstream and downstream
3. Collect construction photographs of each 5% roadway slope monitoring site following construction phase roadway installation (temporary width) and following final roadway installation (permanent width).
4. Typical SWPPP monitoring and maintenance requirements will apply during construction phase of the project.
5. Collect post-construction photographs of the 5% roadway slope monitoring site; upstream and downstream.
6. Following completion of final roadway and shoulder installation (permanent width), place a graduated fence post midway down the 5% roadway slope and at the bottom of the slope in the drainage ditch or shoulder on the side of the road if no drainage ditch is installed. If drainage ditches are installed on both sides of the road, graduated fence posts will be placed in both drainage ditches. The posts should have visible markings every 2" to provide a visual reference within each photograph. Posts should be placed outside of the main flow channel so they are not directly affected by storm flow events.
7. Each fence post location will be referenced by GPS or otherwise identified.
8. GPS or otherwise identify the site where photographs will be taken.
9. Following completion of final roadway and shoulder installation (permanent width), fence posts will be monitored/photographed a minimum two times a year (spring after snow melt and fall). We recommend the fall monitoring occur before September 15, so there will be sufficient time to review the photographs and remedy any problems before winter. Additional monitoring is required after

a summer rainfall event/s accumulating greater than ½ inch of precipitation in an hour as measured at the nearest National Weather Service Monitoring point (if within 10 miles of the site) or at the Facility operations and maintenance building.

10. Photographs will be made available for WGFD review within 30 days.
11. Monitoring will continue for two-years post SWPPP release, and will be re-evaluated by Project Developer and WGFD for necessity following that period.
12. If monitoring shows that impacts are occurring, WGFD and the project developer will meet to discuss what corrective actions need to be taken to remedy the cause of the impact. If impacts are still occurring, additional monitoring maybe recommended.

If the photographs reveal observable changes from erosion or deposition, consultation between WGFD and Project Developer will occur within 30 days after the WGFD receives the photographs.

Channel Geomorphology

1) Perform the Reconnaissance Level Assessment (RLA) of the WARSSS methodology to identify sediment sources and existing channel stability problems.
2) For areas or reaches not excluded in step 1, perform the Rapid Resource Inventory for Sediment and Stability Consequence (RRISSC) to identify and clarify potential natural sediment and channel problem areas and to put potential project-related impacts in context.
3) Based on the results of the RLA and RRISSC, aquatic habitats will be identified either at low risk to change from sediment or runoff changes due to the project or aquatic habitats may experience sediment or runoff changes due to the project. At this stage, it is recommended the project proponent contact the Department to discuss the nature and extent of monitoring needed.
4) If the project will have a low risk to aquatic habitat, no additional monitoring will be recommend.
5) If the detailed assessment indicates aquatic habitats may experience sediment or runoff changes due to the project additional monitoring will be recommended. Monitoring will depend on site-specific conditions.
6) The lowest level of monitoring would entail completing a Rosgen Level II assessment at one reach downstream from the project area (or in an area potentially impacted by the project) and repeating measurements following a high flow/bankfull event or one year from the preconstruction survey. If impacts are indicated during the culverts and roads monitoring, repeating channel measurements may be recommended.
7) The next level of monitoring would entail establishing two Rosgen II stations. Data would be collected downstream from the project area and at one reference reach either upstream of the project area or from a reach having the same stream and valley type. Monitoring would consist of repeating measurements following a high flow/bankfull event or one year from the preconstruction survey and three years from the preconstruction survey.

8) The highest level of monitoring would entail multiple Rosgen II stations. Data would be collected at various locations throughout the project area and at a minimum of one reference reach either upstream of the project area or from a reach having the same stream and valley type. Monitoring would consist of repeating measurements following a high flow/bankfull event or one year from the preconstruction survey and three years from the preconstruction survey.
9) Complete the various intermediate and summary worksheets associated with the Level II work to allow interpretation of project level impacts compared to natural or existing conditions.
10) If monitoring shows that impacts are occurring, WGFD and the project developer will meet to discuss what corrective actions need to be taken to remedy the cause of the impact. If impacts are still occurring, additional monitoring maybe recommended.
11) Field techniques should follow the guidelines outlined in: Harrelson, C.C., C.L. Rawlins and J.P. Potyondy (1994); in Chapter 2 of Rosgen (2008); and in Chapter 5 of Rosgen (1996).
12) All data including GPS locations of cross section pins, upstream and downstream locations, photographs, survey data, pebble count data, etc. should be made available to the WGFD Staff Aquatic Biologist, Environmental Protection Program, within six months.

Storm Water Prevention Plan And Wyoming Construction General Permit
State and Federal laws require wind project developers to develop and submit a Storm Water Prevention Plan (SWPPP) to the Wyoming Department of Environmental Quality (WDEQ) that acts on behalf of the Environmental Protection Agency. The WGFD assumes each SWPPP will adequately address potential erosion issues and each project developer will institute permit stipulations to the best of their ability. However the SWPPP and Wyoming Construction General Permit may be modified to incorporate additional sediment and erosion monitoring. Such modifications could include WGFD monitoring recommendations. Please contact the Department of Environmental Quality for further information on modification of SWPPPs.

Any additional monitoring recommended by WGFD is meant to assist wind project developers and the Department in determining the presence, absence and/or extent of cumulative impacts resulting from changes to upland surface hydrology, erosion, deposition and the potential for impacting habitats important to fish, reptiles, and amphibians. The SWPPP required by the Construction General Permit addresses erosion and sedimentation control during active construction and the immediate post-construction period when revegetation is occurring. The WGFD aquatic recommendations look at the cumulative impacts on a given area of one or more projects over a much longer time frame. Under the Construction General Permit, as soon as vegetation at a construction site reaches 70% of typical background cover, storm water permit coverage is done. The Construction General Permit does not address or allow for monitoring long-term, non-point source pollution. If the Department is interested in long-term sedimentation and its potential for influencing aquatic wildlife, the Construction General Permit will not be helpful and other monitoring would be needed (WDEQ Memo, August 11, 2009).

Concerns have been expressed that channel and sediment monitoring under the WGFD aquatic recommendations duplicates Construction General Permit requirements. The monitoring required under the Construction General Permit only address the functionality of the erosion and sedimentation control best management practices at individual construction sites during the time of construction and revegetation. No downstream sampling for total suspended solids, turbidity or sediment accumulation is required. Theoretically, if all BMP's function well, are properly designed and installed and are well maintained, little or no sediment should leave a construction site. However, BMP's are only in place for a short time. Long-term monitoring addresses how the project, as designed, functions over time with respect to hydrology and sediment transport (WDEQ Memo, August 11, 2009).

Table 4: SGCN Fish Species (2005)

Bluehead Sucker	NSS1
Finescale Dace	NSS1
Flannelmouth Sucker	NSS1
Hornyhead Chub	NSS1
Leatherside Chub	NSS1
Pearl Dace	NSS1
Roundtail Chub	NSS1
Sturgeon Chub	NSS1
Suckermouth Minnow	NSS1
Western Silvery Minnow	NSS1
Bonneville Cutthroat Trout	NSS2
Burbot	NSS2
Colorado River Cutthroat Trout	NSS2
Goldeye	NSS2
Kendall WS Dace	NSS2
Orangethroat Darter	NSS2
Plains Topminnow	NSS2
Sauger	NSS2
Shovelnose Sturgeon	NSS2
Yellowstone Cutthroat Trout	NSS2
Black Bullhead	NSS3
Common Shiner	NSS3
Flathead Chub	NSS3
Lake Chub	NSS3
Mountain Sucker	NSS3
Plains Minnow	NSS3

RECLAMATION RECOMMENDATIONS

1. **Erosion Control:** Use best management practices to control erosion and prevent sediment from reaching nearby waterways.

2. **Topsoil:** Save topsoil removed for construction activities and spread over the disturbed area as soon as possible after disturbance to accelerate natural and artificial re-vegetation.

3. **Re-vegetation:** Prompt reclamation is essential as this can help minimize erosion issues and return lands to a useable condition for wildlife and livestock. We encourage private landowners to consider our reclamation recommendations on their property where it meets their operational management needs.

    a. Carefully plan for establishing a complex of vegetation that reflects the diversity of plant species and habitats in the surrounding area.
    b. Livestock grazing should be deferred until plants become established, which is typically two growing seasons.
    c. We recommend using only native grass/forb species palatable to wildlife.
    d. If hay or straw is used as mulch, it should be certified weed free.
    e. Monitoring reclamation for noxious and undesirable weeds should occur during and after construction with subsequent control as needed.
    f. Avoid planting monocultures.

4. **Accelerating Reclamation:** Reclamation may be accelerated by the use of locally derived cultivars and by mycorrhizal inoculations of shrubs and trees. In sagebrush habitat, prepare fire and weed control plans to protect both reclamation and adjacent sagebrush.

MITIGATION RECOMMENDATIONS

Current research is inadequate to determine the level of impact by wind energy development for most species of wildlife. A mitigation plan will be recommended outlining compensatory habitat conservation practices for offsetting wildlife losses in habitats defined as "vital" in the WGFC Mitigation Policy (focus management areas for SGCN species, big game crucial habitat, wetlands, and Blue Ribbon streams), if monitoring determines declines due to development in these habitats. Maps of these areas are available from WGFD.

APPENDIX C
ACRONYMS

APLIC .....Avian Powerline Interaction Committee
BACI .....*Before-After Control-Impact*
BLM .....Bureau of Land Management
BMPs .....Best Management Practices
DOE .....U.S. Department of Energy
DOI .....Department of the Interior
ESA .....Endangered Species Act
FAC .....Federal Advisory Committee on Wind
MWs.....Megawatts
PLA .....Prediction Level Assessment
RLA .....The Reconnaissance Level Assessment
RRISSC..... Rapid Resource Inventory for Sediment and Stability Consequence
SGCN .....Species of Greatest Conservation Need
SWPPP..... Storm Water Prevention Plan
TAC .....Technical Advisory Committee
TMDL .....Total Maximum Daily Load
WARSSS…… Watershed Assessment of River Stability and Sediment Supply
WISC..... Wyoming Industrial Siting Council
WDEQ.....Wyoming Department of Environmental Quality
WGFC .....Wyoming Game and Fish Commission
WGFD .....Wyoming Game and Fish Department
WYBWG .....Wyoming Bat Working Group
WYNDD .....Wyoming Natural Diversity Database

STATE OF NEVADA

DEPARTMENT OF WILDLIFE

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June 21, 2011

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Department of the Interior
1849 C Street NW
Washington, DC 20240

Director Robert Abbey
Bureau of Land Management
U.S. Department of the Interior
1849 C Street NW, Room 5665
Washington, DC 20240

Director David White
Natural Resources Conservation Service
14th and Independence Avenue, SW, Room 5105-S
Washington, DC 20250

Dear Director Ashe, Abbey and White:

On behalf of Director Tom Remington, Colorado, Director Virgil Moore, Idaho and Deputy Director John Emmerich, Wyoming and myself, I want to take this opportunity to thank you for hosting our interagency meeting on the listing of the Greater sage-grouse. Our assessment of the meeting was that it was a success! Our goal was to have a frank discussion about the gravity of the situation if the bird receives the full protection of the Endangered Species Act (Act) and the steps we all need to take to prevent this.

Because the Greater sage-grouse was determined to be warranted for listing based largely on two listing factors identified in the Act (the present or threatened destruction, modification or curtailment of its habitat, and the inadequacy of existing regulatory mechanisms) it is clear to us what needs to occur. The USFWS has stated several times, that either factor by itself can result in a warranted listing determination.

Considering this fact, it is clear that there needs to be a long-term habitat solution that both Federal agencies and state wildlife agencies must work together to address. Fortunately, there is a lot of work being done in this arena, we just need to maintain or increase the level of funding and continue to actively work on habitat issues. Thanks to Chief White for the financial support from Natural Resources Conservation Service, as we are making significant progress on the habitat front. However, habitat restoration takes time and our experiences have told us this effort may take decades to realize the full benefits.

In the short term, affecting change to the regulatory mechanisms that govern habitat impacts is crucial to addressing the other major listing factors that led to the listing decision. Hence, we believe that a well crafted "regional" regulatory mechanism is essential to providing the necessary assurances to address the essential habitat requirements for long-term habitat protection for the sage-grouse. At a minimum, these would be revisions and amendments at the level of the Western Association of Fish and Wildlife Agencies (WAFWA) Sage-grouse Management Zones, which were identified on the basis of their ecological and biological attributes, and commonality of threats to the species. Because, the BLM administers over 50 percent of the estimated sage-grouse habitat across its range, a large share of this responsibility falls on its shoulders. Thus, BLM must lead the way in reducing the major threats on their lands by developing a "range-wide" programmatic EIS or some other regional approach to these regulatory mechanisms. Because Greater sage-grouse are a landscape scale species, requiring thousands of acres to meet their annual seasonal requirements, our work must be approached at a similar scale. We are convinced that a piecemeal approach will not provide the necessary protection.

During our meeting we also discussed what needs to be done during the time while the range-wide plan amendments are being prepared. It is critical that while regulatory mechanisms are being addressed through the revisions of Resource Management Plans (RMP's), it is very important that activities on the ground currently being reviewed, prior to amending RMPs, not result in a cumulative loss or further fragmentation of habitat. This will only further harm the species and move it towards full listing. The BLM must ensure that the status of the species does not continue to decline such that new regulatory mechanisms developed and implemented over the next few years will be too late to benefit the species.

Specifically, we encourage continued attention and efforts in wildland fire suppression, as this was identified as the primary habitat concern within much of the Great Basin area. Continuing this effort is essential to long-term conservation of the bird. Additionally, we encourage the use of strong Instructional Memorandums (IMs) (similar to the one regarding fire suppression) to use as a temporary measure to ensure current activities are considered in light of sage-grouse conservation and listing. Using IMs on an interim basis as guidance throughout the sage grouse range are essential until the RMP's can be amended or revised.

As we discussed at our meeting, time is of the essence because a final listing determination for the Greater sage-grouse will be made by USFWS at the end of Fiscal Year 2015. Thus, we strongly urge the BLM to move quickly and determine a course of action in developing adequate regulatory mechanisms for the conservation of the Greater sage-grouse. We appreciate everyone's consideration and commitment to the conservation of this species. I'm sure that everyone will agree that communication will be essential to accomplish this. Thus, we request a commitment from all the agencies involved that all employees understand the importance of the conservation of sage-grouse and the steps we as the leaders of our respective agencies have chosen to conserve the bird and its habitat. From our conversations it was clear that such clear direction will be essential to us achieving our goal.

The WAFWA states will continue to be available to help you in any way we can. We appreciate everyone's efforts to improve the status of sage-grouse so as to preclude the need to list, and particularly want to thank the BLM for their stated commitment to an expedited programmatic EIS. Again, thank you for taking time out of your busy schedule to meet on this important subject and we look forward to hearing about progress and plans at the Greater Sage-Grouse Executive Oversight Committee meeting at the WAFWA summer Annual Meeting July 16, 2011.

Sincerely,

Kenneth E. Mayer

Kenneth E. Mayer
Acting Director

kem:ss

cc: Acting USFWS Service Director Rowan Gould; BLM Deputy Director of Operations Mike Pool; Madeline West, Western Governors' Association; Ryan McGinness, Director Nevada's Washington D.C. Office; Noreen Walsh, USFWS Deputy Regional Director Mountain Prairie Region; Dwight Fielder, BLM Division Chief; Director Tom Remington, Colorado Division of Wildlife; Director Virgil Moore, Idaho Department of Fish and Game; Deputy Director John Emmerich, Wyoming Fish and Game

Proposed Rules

This section of the FEDERAL REGISTER contains notices to the public of the proposed issuance of rules and regulations. The purpose of these notices is to give interested persons an opportunity to participate in the rule making prior to the adoption of the final rules.

DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[FWS-R6-ES-2010-0018]
[MO 92210-0-0008-B2]

Endangered and Threatened Wildlife and Plants; 12-Month Findings for Petitions to List the Greater Sage-Grouse (*Centrocercus urophasianus*) as Threatened or Endangered

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice of 12–month petition findings.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), announce three 12–month findings on petitions to list three entities of the greater sage-grouse (*Centrocercus urophasianus*) as threatened or endangered under the Endangered Species Act of 1973, as amended (Act). We find that listing the greater sage-grouse (rangewide) is warranted, but precluded by higher priority listing actions. We will develop a proposed rule to list the greater sage-grouse as our priorities allow.

We find that listing the western subspecies of the greater sage-grouse is not warranted, based on determining that the western subspecies is not a valid taxon and thus is not a listable entity under the Act. We note, however, that greater sage-grouse in the area covered by the putative western subspecies (except those in the Bi-State area (Mono Basin), which are covered by a separate finding) are encompassed by our finding that listing the species is warranted but precluded rangewide.

We find that listing the Bi-State population (previously referred to as the Mono Basin area population), which meets our criteria as a distinct population segment (DPS) of the greater sage-grouse, is warranted but precluded by higher priority listing actions. We will develop a proposed rule to list the Bi-State DPS of the greater sage-grouse as our priorities allow, possibly in conjunction with a proposed rule to list the greater sage-grouse rangewide.

DATES: The finding announced in the document was made on [*insert date of publication in the* **Federal Register**].

ADDRESSES: This finding is available on the Internet at *http://www.regulations.gov* and *www.fws.gov*. Supporting documentation we used to prepare this finding is available for public inspection, by appointment, during normal business hours at the U.S. Fish and Wildlife Service, 5353 Yellowstone Road, Suite 308A, Cheyenne, Wyoming 82009; telephone (307) 772-2374; facsimile (307) 772-2358. Please submit any new information, materials, comments, or questions concerning this species to the Service at the above address.

FOR FURTHER INFORMATION CONTACT: Brian T. Kelly, Field Supervisor, U.S. Fish and Wildlife Service, Wyoming Ecological Services Office (see **ADDRESSES**). If you use a telecommunications device for the deaf (TDD), call the Federal Information Relay Service (FIRS) at (800) 877-8339.

SUPPLEMENTARY INFORMATION:

Background

Section 4(b)(3)(B) of the Act (16 U.S.C. 1531 *et seq.*), requires that, for any petition containing substantial scientific or commercial information that the listing may be warranted, we make a finding within 12 months of the date of the receipt of the petition on whether the petitioned action is (a) not warranted, (b) warranted, or (c) warranted, but that immediate proposal of a regulation implementing the petitioned action is precluded by other pending proposals to determine whether species are threatened or endangered, and expeditious progress is being made to add or remove qualified species from the Lists of Endangered and Threatened Wildlife and Plants. Section 4(b)(3)(C) of the Act requires that we treat a petition for which the requested action is found to be warranted but precluded as though resubmitted on the date of such finding; that is, requiring a subsequent finding to be made within 12 months. We must publish these 12–month findings in the **Federal Register**.

Previous Federal Action

Greater Sage-Grouse

On July 2, 2002, we received a petition from Craig C. Dremann requesting that we list the greater sage-grouse (*Centrocercus urophasianus*) as endangered across its entire range. We received a second petition from the Institute for Wildlife Protection on March 24, 2003, requesting that the greater sage-grouse be listed rangewide. On December 29, 2003, we received a third petition from the American Lands Alliance and 20 additional conservation organizations (American Lands Alliance *et al.*) to list the greater sage-grouse as threatened or endangered rangewide. On April 21, 2004, we announced our 90–day petition finding in the **Federal Register** (69 FR 21484) that these petitions taken collectively, as well as information in our files, presented substantial information indicating that the petitioned actions may be warranted. On July 9, 2004, we published a notice to reopen the period for submitting comments on our 90–day finding, until July 30, 2004 (69 FR 41445). In accordance with section 4(b)(3)(A) of the Act, we completed a status review of the best available scientific and commercial information on the species. On January 12, 2005, we announced our not-warranted 12–month finding in the **Federal Register** (70 FR 2243).

On July 14, 2006, Western Watersheds Project filed a complaint in Federal district court alleging that the Service's 2005 12–month finding was incorrect and arbitrary and requested the finding be remanded to the Service. On December 4, 2007, the U.S. District Court of Idaho ruled that our 2005 finding was arbitrary and capricious, and remanded it to the Service for further consideration. On January 30, 2008, the court approved a stipulated agreement between the Department of Justice and the plaintiffs to issue a new finding in May 2009, contingent on the availability of a new monograph of information on the sage-grouse and its habitat (Monograph). On February 26, 2008, we published a notice to initiate a status review for the greater sage-grouse (73 FR 10218), and on April 29, 2008, we published a notice extending the request for submitting information to June 27, 2008 (73 FR 23172). Publication of the Monograph was

delayed due to circumstances outside the control of the Service. An amended joint stipulation, adopted by the court on June 15, 2009, required the Service to submit the 12–month finding to the **Federal Register** by February 26, 2010; this due date was subsequently extended to March 5, 2010.

Western Subspecies of the Greater Sage-Grouse

The western subspecies of the greater sage-grouse (*Centrocercus urophasianus phaios*) was identified by the Service as a category 2 candidate species on September 18, 1985 (50 FR 37958). At the time, we defined Category 2 species as those species for which we possessed information indicating that a proposal to list as endangered or threatened was possibly appropriate, but for which conclusive data on biological vulnerability and threats were not available to support a proposed rule. On February 28, 1996, we discontinued the designation of category 2 species as candidates for listing under the Act (61 FR 7596), and consequently the western subspecies was no longer considered to be a candidate for listing.

We received a petition, dated January 24, 2002, from the Institute for Wildlife Protection requesting that the western subspecies occurring from northern California through Oregon and Washington, as well as any western sage-grouse still occurring in parts of Idaho, be listed under the Act. The petitioner excluded the Mono Basin area populations in California and northwest Nevada since they already had petitioned this population as a distinct population segment (DPS) for emergency listing (see discussion of Bi-State area (Mono Basin) population below). The petitioner also requested that the Service include the Columbia Basin DPS in this petition, even though we had already identified this DPS as a candidate for listing under the Act (66 FR 22984, May 7, 2001) (see discussion of Columbia Basin below).

We published a 90–day finding on February 7, 2003 (68 FR 6500), that the petition did not present substantial information indicating the petitioned action was warranted based on our determination that there was insufficient evidence to indicate that the petitioned western population of sage-grouse is a valid subspecies or DPS. The petitioner pursued legal action, first with a 60–day Notice of Intent to sue, followed by filing a complaint in Federal district court on June 6, 2003, challenging the merits of our 90–day finding. On August 10, 2004, the U.S. District Court for the Western District of Washington ruled in favor of the Service (Case No. C03-1251P). The petitioner appealed and on March 3, 2006, the U.S. Court of Appeals for the Ninth Circuit reversed in part the ruling of the District Court and remanded the matter for a new 90–day finding (*Institute for Wildlife Protection* v. *Norton*, 2006 U.S. App. LEXIS 5428 9th Cir., March 3, 2006). Specifically, the Court of Appeals rejected the Service's conclusion that the petition did not present substantial information indicating that western sage-grouse may be a valid subspecies, but upheld the Service's determination that the petition did not present substantial information indicating that the petitioned population may constitute a DPS. The Court's primary concern was that the Service did not provide a sufficient description of the principles we employed to determine the validity of the subspecies classification. On April 29, 2008, we published in the **Federal Register** (73 FR 23170) a 90–day finding that the petition presented substantial scientific or commercial information indicating that listing western sage-grouse may be warranted and initiated a status review for western sage-grouse.

In a related action, the Service also has made a finding on a petition to list the eastern subspecies of the greater sage-grouse (*Centrocercus urophasianus urophasianus*). On July 3, 2002, we received a petition from the Institute for Wildlife Protection to list the eastern subspecies, identified in the petition as including all sage-grouse east of Oregon, Washington, northern California, and a small portion of Idaho. The petitioners sued the Service in U.S. District Court on January 10, 2003, for failure to complete a 90–day finding. On October 3, 2003, the Court ordered the Service to complete a finding. The Service published its not-substantial 90–day finding in the **Federal Register** on January 7, 2004 (69 FR 933), based on our determination that the eastern sage-grouse was not a valid subspecies. The not-substantial finding was challenged, and on September 28, 2004, the U.S. District Court ruled in favor of the Service, dismissing the plaintiff's case.

Columbia Basin (Washington) Population of the Western Subspecies

On May 28, 1999, we received a petition dated May 14, 1999, from the Northwest Ecosystem Alliance and the Biodiversity Legal Foundation. The petitioners requested that the Washington population of western sage-grouse (*C. u. phaios*) be listed as threatened or endangered under the Act. The petitioners requested listing of the Washington population of western sage-grouse based upon threats to the population and its isolation from the remainder of the taxon. Accompanying the petition was information relating to the taxonomy, ecology, threats, and the past and present distribution of western sage-grouse.

In our documents we have used ''Columbia Basin population'' rather than ''Washington population'' because we believe it more appropriately describes the petitioned entity. We published a substantial 90–day finding on August 24, 2000 (65 FR 51578). On May 7, 2001, we published our 12–month finding (66 FR 22984), which included our determination that the Columbia Basin population of the western sage-grouse met the requirements of our policy on DPSs (61 FR 4722) and that listing the DPS was warranted but precluded by other higher priority listing actions. As required by section 4(b)(3)(C) of the Act, we have subsequently made resubmitted petition findings, announced in conjunction with our Candidate Notices of Review, in which we continued to find that listing the Columbia Basin DPS of the western subspecies was warranted but precluded by other higher priority listing actions (66 FR 54811, 67 FR 40663, 69 FR 24887, 70 FR 24893, 74 FR 57803). Subsequent to the March 2006 decision by the court on our 90–day finding on the petition to list the western subspecies of the greater sage-grouse (described above), our resubmitted petition findings stated we were not updating our analysis for the DPS, but would publish an updated finding regarding the petition to list the Columbia Basin population of the western subspecies following completion of the new rangewide status review for the greater sage-grouse.

Bi-State Area (Mono Basin) Population of Sage-grouse

On January 2, 2002, we received a petition from the Institute for Wildlife Protection requesting that the sage-grouse occurring in the Mono Basin area of Mono County, California, and Lyon County, Nevada, be emergency listed as an endangered distinct population segment (DPS) of *Centrocercus urophasianus phaios*, which the petitioners considered to be the western subspecies of the greater sage-grouse. This request was for portions of Alpine and Inyo Counties and most of Mono County in California and portions of Carson City, Douglas, Esmeralda, Lyon, and Mineral Counties in Nevada. On December 26, 2002, we published a 90–day finding that the petition did not present substantial scientific or commercial information indicating that the petitioned action may be warranted

(67 FR 78811). Our 2002 finding was based on our determination that the petition did not present substantial information indicating that the population of greater sage-grouse in this area was a DPS under our DPS policy (61 FR 4722; February 7, 1996), and thus was not a listable entity (67 FR 78811; December 26, 2002). Our 2002 finding also included a determination that the petition did not present substantial information regarding threats to indicate that listing the petitioned population may be warranted (67 FR 78811).

On November 15, 2005, we received a petition submitted by the Stanford Law School Environmental Law Clinic on behalf of the Sagebrush Sea Campaign, Western Watersheds Project, Center for Biological Diversity, and Christians Caring for Creation to list the Mono Basin area population of greater sage-grouse as a threatened or endangered DPS of the greater sage-grouse (*C. urophasianus*) under the Act. On March 28, 2006, we responded that emergency listing was not warranted and, due to court orders and settlement agreements for other listing actions, we would not be able to address the petition at that time.

On November 18, 2005, the Institute for Wildlife Protection and Dr. Steven G. Herman sued the Service in U.S. District Court for the Western District of Washington (*Institute for Wildlife Protection et al.* v. *Norton et al.*, No. C05-1939 RSM), challenging the Service's 2002 finding that their petition did not present substantial information indicating that the petitioned action may be warranted. On April 11, 2006, we reached a stipulated settlement agreement with both plaintiffs under which we agreed to evaluate the November 2005 petition and concurrently reevaluate the December 2001 petition (received in January 2002). The settlement agreement required the Service to submit to the **Federal Register** a 90–day finding by December 8, 2006, and if substantial, to complete the 12–month finding by December 10, 2007. On December 19, 2006, we published a 90–day finding that these petitions did not present substantial scientific or commercial information indicating that the petitioned actions may be warranted (71 FR 76058).

On August 23, 2007, the November 2005 petitioners filed a complaint challenging the Service's 2006 finding. After review of the complaint, the Service determined that we would revisit our 2006 finding. The Service entered into a settlement agreement with the petitioners on February 25, 2008, in which the Service agreed to a voluntary remand of the 2006 petition finding, and to submit for publication in the **Federal Register** a new 90–day finding by April 25, 2008. The agreement further stipulated that if the new 90–day finding was positive, the Service would undertake a status review of the Mono Basin area population of the greater sage-grouse and submit for publication in the **Federal Register** a 12–month finding by April 24, 2009.

On April 29, 2008, we published in the **Federal Register** (73 FR 23173) a 90–day petition finding that the petitions presented substantial scientific or commercial information indicating that listing the Mono Basin area population may be warranted and initiated a status review. Based on a joint stipulation by the Service and the plaintiffs to extend the due date for the 12–month finding, on April 23, 2009, the U.S. District Court, Northern District of California, issued an order that if the parties did not agree to a later alternative date, the Service would submit a 12–month finding for the Mono Basin population of the greater sage-grouse to the **Federal Register** no later than May 26, 2009. On May 27, 2009, the U.S. District Court, Northern District of California, issued an order accepting a joint stipulation between the Department of Justice and the plaintiffs, which states that the parties agree that the Service may submit to the **Federal Register** a single document containing the 12–month findings for the Mono Basin area population and the greater sage-grouse no later than by February 26, 2010. Subsequently, the due date for submission of the document to the **Federal Register** was extended to March 5, 2010.

Both the November 2005 and the December 2001 petitions as well as our 2002 and 2006 findings use the term ''Mono Basin area'' to refer to greater sage-grouse that occur within the geographic area of eastern California and western Nevada that includes Mono Lake. For conservation planning purposes, this same geographic area is referred to as the Bi-State area by the States of California and Nevada (Greater Sage-grouse Conservation Plan for Nevada and Eastern California, 2004, pp. 4–5). For consistency with ongoing planning efforts, we will adopt the ''Bi-State'' nomenclature hereafter in this finding.

Biology and Ecology of Greater Sage-Grouse

Greater Sage-Grouse Description

The greater sage-grouse (*Centrocercus urophasianus*) is the largest North American grouse species. Adult male greater sage-grouse range in length from 66 to 76 centimeters (cm) (26 to 30 inches (in.)) and weigh between 2 and 3 kilograms (kg) (4 and 7 pounds (lb)). Adult females are smaller, ranging in length from 48 to 58 cm (19 to 23 in.) and weighing between 1 and 2 kg (2 and 4 lb). Males and females have dark grayish-brown body plumage with many small gray and white speckles, fleshy yellow combs over the eyes, long pointed tails, and dark green toes. Males also have blackish chin and throat feathers, conspicuous phylloplumes (specialized erectile feathers) at the back of the head and neck, and white feathers forming a ruff around the neck and upper belly. During breeding displays, males exhibit olive-green apteria (fleshy bare patches of skin) on their breasts (Schroeder *et al.* 1999, p. 2).

Taxonomy

Greater sage-grouse are members of the Phasianidae family. They are one of two congeneric species; the other species in the genus is the Gunnison sage-grouse (*Centrocercus minimus*). In 1957, the American Ornithologists' Union (AOU) (AOU 1957, p 139) recognized two subspecies of the greater sage-grouse, the eastern (*Centrocercus urophasianus urophasianus)* and western (*C. u. phaios)* based on information from Aldrich (1946, p. 129). The original subspecies designation of the western sage-grouse was based solely on differences in coloration (specifically, reduced white markings and darker feathering on western birds) among 11 museum specimens collected from 8 locations in Washington, Oregon, and California. The last edition of the AOU Check-list of North American Birds to include subspecies was the 5th Edition, published in 1957. Subsequent editions of the Check-list have excluded treatment of subspecies. Richard Banks, who was the AOU Chair of the Committee on Classification and Nomenclature in 2000, indicated that, because the AOU has not published a revised edition at the subspecies level since 1957, the subspecies in that edition, including the western sage-grouse, are still recognized (Banks 2000, pers. comm.). However, in the latest edition of the Check-list (7th Ed., 1998, p. xii), the AOU explained that its decision to omit subspecies, ''carries with it our realization that an uncertain number of currently recognized subspecies, especially those formally named early in this century, probably cannot be validated by rigorous modern techniques.''

Since the publication of the 1957 Check-list, the validity of the subspecies designations for greater sage-grouse has

been questioned, and in some cases dismissed, by several credible taxonomic authorities (Johnsgard 1983, p. 109; Drut 1994, p. 2; Schroeder *et al.* 1999, p. 3; International Union for Conservation of Nature (IUCN) 2000, p. 62; Banks 2000, 2002 pers. comm.; Johnsgard 2002, p. 108; Benedict *et al.* 2003, p. 301). The Western Association of Fish and Wildlife Agencies (WAFWA), an organization of 23 State and provincial agencies charged with the protection and management of fish and wildlife resources in the western part of the United States and Canada, also questioned the validity of the western sage-grouse as a subspecies in its Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats (Connelly *et al.* 2004, pp. 8-4 to 8-5). Furthermore, in its State conservation assessment and strategy for greater sage-grouse, the Oregon Department of Fish and Wildlife (ODFW) stated that ''recent genetic analysis (Benedict *et al.* 2003) found little evidence to support this subspecies distinction, and this Plan refers to sage-grouse without reference to subspecies delineation in this document'' (Hagen 2005, p. 5).

The Integrated Taxonomic Information System (ITIS), a database representing a partnership of U.S., Canadian, and Mexican agencies, other organizations, and taxonomic specialists designed to provide scientifically credible taxonomic information, lists the taxonomic status of western sage-grouse as ''invalid – junior synonym'' (ITIS 2010). In an evaluation of the historical classification of the western sage-grouse as a subspecies, Banks stated that it was ''weakly characterized'' but felt that it would be wise to continue to regard western sage-grouse as taxonomically valid ''for management purposes'' (Banks, pers. comm. 2000). This statement was made prior to the availability of behavioral and genetic information that has become available since 2000. In addition, Banks' opinion is qualified by the phrase ''for Management purposes.'' Management recommendations and other considerations must be clearly distinguished from scientific or commercial data that indicate whether an entity may be taxonomically valid for the purpose of listing under the Act.

Although the Service had referred to the western sage-grouse in past decisions (for example, in the 12–month finding for a petition to list the Columbia Basin population of western sage-grouse, 66 FR 22984; May 7, 2001), this taxonomic reference was ancillary to the decision at hand and was not the focal point of the listing action. In other words, when past listing actions were focused on some other entity, such as a potential distinct population segment in the State of Washington, we accepted the published taxonomy for western sage-grouse because that taxonomy itself was not the subject of the review and thus not subject to more rigorous evaluation at the time.

Taxonomy is a component of the biological sciences. Therefore, in our evaluation of the reliability of the information, we considered scientists with appropriate taxonomic credentials (which may include a combination of education, training, research, publications, classification and/or other experience relevant to taxonomy) as qualified to provide informed opinions regarding taxonomy, make taxonomic distinctions, and/or question taxonomic classification.

There is no universally accepted definition of what constitutes a subspecies, and the use of subspecies may vary between taxonomic groups (Haig *et al.* 2006, pp. 1584-1594). The Service acknowledges the diverse opinions of the scientific community about species and subspecies concepts. However, to be operationally useful, subspecies must be discernible from one another (i.e., diagnosable); this element of ''diagnosability,'' or the ability to consistently distinguish between populations, is a common thread that runs through all subspecies concepts. The AOU Committee on Classification and Nomenclature offers the following definition of a subspecies: ''Subspecies should represent geographically discrete breeding populations that are diagnosable from other populations on the basis of plumage and/or measurements, but are not yet reproductively isolated. Varying levels of diagnosability have been proposed for subspecies, typically ranging from at least 75% to 95% * * * subspecies that are phenotypically but not genetically distinct still warrant recognition if individuals can be assigned to a subspecies with a high degree of certainty'' (AOU 2010). In addition, the latest AOU Check-list of North American Birds describes subspecies as: ''geographic segments of species' populations that differ abruptly and discretely in morphology or coloration; these differences often correspond with difference in behavior and habitat'' (AOU 1998, p. xii).

In general, higher levels of confidence in the classification of subspecies may be gained through the concurrence of multiple morphological, molecular, ecological, behavioral, and/or physiological characters (Haig *et al.* 2006, p. 1591). The AOU definition of subspecies also incorporates this concept of looking for multiple lines of evidence, in referring to abrupt and discrete differences in morphology, coloration, and often corresponding differences in behavior or habitat as well (AOU 1998, p. xii). To assess subspecies diagnosability, we evaluated all the best scientific and commercial information available to determine whether the evidence points to a consistent separation of birds currently purported to be ''western sage-grouse'' from other populations of greater sage-grouse. This evaluation incorporated information that has become available since the AOU's last subspecies review in 1957, and included data on the geographic separation of the putative eastern and western subspecies, behavior, morphology, and genetics. If the assessment of these multiple characters provided a clear and consistent separation of the putative western subspecies from other populations of sage-grouse, such that any individual bird from the range of the western sage-grouse would likely be correctly assigned to that subspecies on the basis of the suite of characteristics analyzed, that would be considered indicative of a likely valid subspecies.

Geography

The delineation between eastern and western subspecies is vaguely defined and has changed over time from its original description (Aldrich 1946, p. 129; Aldrich and Duvall 1955 p. 12; AOU 1957, p. 139; Aldrich 1963, pp. 539-541). The boundary between the subspecies is generally described along a line starting on the Oregon–Nevada border south of Hart Mountain National Wildlife Refuge and ending near Nyssa, Oregon (Aldrich and Duvall 1955, p. 12; Aldrich 1963, pp. 539-541). Aldrich described the original eastern and western ranges in 1946 (Aldrich 1946, p. 129), while Aldrich and Duvall (1955, p. 12) and Aldrich (1963, pp. 539-541) described an intermediate form in northern California, presumably in a zone of intergradation between the subspecies. All of Aldrich's citations include a portion of Idaho within the western subspecies' range, but the 1957 AOU designation included Idaho as part of the eastern subspecies (AOU 1957, p. 139).

Our evaluation reveals that a boundary between potential western and eastern subspecies may be drawn multiple ways depending on whether one uses general description of historical placement, by considering topographic features, or in response to the differing patterns reported in studying sage-grouse genetics, morphology, or behavior. In their

description of greater sage-grouse distribution, Schroeder *et al.* (2004, p. 369) noted the lack of evidence for differentiating between the purported subspecies, stating ''We did not quantify the respective distributions of the eastern and western subspecies because of the lack of a clear dividing line (Aldrich and Duvall 1955) and the lack of genetic differentiation (Benedict *et al.* 2003).'' Based on this information, there does not appear to be any clear and consistent geographic separation between sage-grouse historically described as ''eastern'' and ''western.''

Morphology

As noted above, the original description of the western subspecies of sage-grouse was based solely on differences in coloration (specifically, reduced white markings and darker feathering on western birds) among 11 museum specimens (10 whole birds, 1 head only) collected from 8 locations in Washington, Oregon, and California (Aldrich 1946, p. 129). By today's standards, this represents an extremely small sample size that would likely yield little confidence in the ability to discriminate between populations on the basis of this character. Furthermore, the subspecies designation was based on this single characteristic; no other differences between the western and eastern subspecies of sage-grouse were noted in Aldrich's original description (Aldrich 1946, p. 129; USFWS 2010). Banks (1992) noted plumage color variation in the original specimens Aldrich (1946) used to make his subspecies designation, and agreed that the specimens from Washington, Oregon, and northern California did appear darker than the specimens collected in the eastern portion of the range. However, individual morphological variation in greater sage-grouse, such as plumage coloration, is extensive (Banks 1992). Further, given current taxonomic concepts, Banks (1992) doubted that most current taxonomists would identify a subspecies based on minor color variations from a limited number of specimens, as were available to Aldrich during the mid-1900s (Aldrich 1946, p. 129; Aldrich and Duvall 1955, p. 12; Aldrich 1963, pp. 539-541). Finally, the AOU Committee on Classification has stated that, because of discoloration resulting from age and poor specimen preparation, museum specimens ''nearly always must be supplemented by new material for comprehensive systematic studies.'' (AOU, Check-list of North American Birds, 7th ed., 1998, p. xv.)

Schroeder (2008, pp. 1-19) examined previously collected morphological data across the species' range from both published and unpublished sources. He found statistically significant differences between sexes, age groups, and populations in numerous characteristics including body mass, wing length, tail length, and primary feather length. Many of these differences were associated with sex and age, but body mass also varied by season. There also were substantial morphometric (size and shape) differences among populations. Notably, however, these population differences were not consistent with any of the described geographic delineations between eastern and western subspecies. For example, sage-grouse from Washington and from Northern Colorado up to Alberta appeared to be larger than those in Idaho, Nevada, Oregon, and California (Schroeder 2008, p. 9). This regional variation was not consistent with differences in previously established genetic characteristics (Oyler-McCance *et al.* 2005, as cited in Schroeder 2008, p. 9). Thus our review revealed no clear basis for differentiating between the two described subspecies based on plumage or morphology.

Behavior

The only data available with respect to behavior are for strutting behavior on leks, a key component of mate selection. One recent study compared the male strut behavior between three sage-grouse populations that happen to include populations from both sides of the putative eastern-western line (Taylor and Young 2006, pp. 36-41). However, the classification of these populations changes depending on the description of western sage-grouse used. The Lyon/Mono population falls within the intermediate zone identified by Aldrich and Duvall (1955, p. 12) but would be classified as eastern under Aldrich (1963, p. 541). The Lassen population may be considered either western (Aldrich 1946, p. 129) or intermediate (Aldrich and Duvall 1955, p. 12; Aldrich 1963, p. 541). The Nye population falls within the range of the eastern sage-grouse (Aldrich and Duvall 1955, p. 12; Aldrich 1963, p. 541). The researchers found that male strut rates were not significantly different between populations, but that acoustic components of the display for the Lyon/Mono and Lassen populations (considered intermediate and/or western) were similar to each other, whereas the Nye population (eastern) was distinct. We consider these results inconclusive in distinguishing between eastern and western subspecies because of the inconsistent results and limited geographic scope of the study.

Schroeder (2008, p. 9) also examined previously collected data on strutting behavior on leks, including Taylor and Young (2006). He noted that, although there was regional variation in the strut rate of sage-grouse, it was not clear if this variation reflected population-level effects or some other unexplained variation. Based on the above limited information, we do not consider there to be any strong evidence of a clear separation of the western sage-grouse from other populations on the basis of behavioral differences.

Genetics

Genetic research can sometimes augment or refine taxonomic definitions that are based on morphology or behavior or both (discussed in Haig *et al.* 2006, p. 1586; Oyler-McCance and Quinn in press, p. 19). Benedict *et al.* (2003, p. 309) found no genetic data supporting a subspecies designation. To investigate taxonomic questions and examine levels of gene flow and connectedness among populations, Oyler-McCance *et al.* (2005, p. 1294) conducted a comprehensive examination of the distribution of genetic variation across the entire range of greater sage-grouse, using both mitochondrial and nuclear deoxyribonucleic acid (DNA) sequence data. Oyler-McCance *et al.* (2005, p. 1306) found that the overall distribution of genetic variation showed a gradual shift across the range in both mitochondrial and nuclear DNA data sets. Their results demonstrate that greater sage-grouse populations follow an isolation-by-distance model of restricted gene flow (gene flow resulting from movement between neighboring populations rather than being the result of long distance movements of individuals) (Oyler-McCance *et al.* 2005, p. 1293; Campton 2007, p. 4), and are not consistent with subspecies designations. Oyler-McCance and Quinn (in press, entire) reviewed available studies that used molecular genetic approaches, including Oyler-McCance *et al.* (2005). They examined the genetic data bearing on the delineation of the western and eastern subspecies of greater sage-grouse, and determined that the distinction is not supported by the genetic data (Oyler-McCance and Quinn in press, p. 4). The best available genetic information thus does not support the recognition of the western sage-grouse as a separate subspecies.

Summary: Taxonomic Evaluation of the Subspecies

The AOU has not revisited the question of whether the eastern and western subspecies are valid since their

original classification in 1957. We have examined the best scientific information available regarding the putative subspecies of the greater sage-grouse and have considered multiple lines of evidence for the potential existence of western and eastern subspecies based on geographic, morphological, behavioral, and genetic data. In our evaluation, we looked for any consistent significant differences in these characters that might support recognition of the western or eastern sage-grouse as clear, discrete, and diagnosable populations, such that either might be considered a subspecies.

As described above, the boundaries distinguishing the two putative subspecies have shifted over time, and there does not appear to be any clear and consistent geographic separation between sage-grouse historically described as ''eastern'' and ''western.'' Banks (1992) and Schroeder (2008, p. 9) both found morphological variations between individuals and populations, but Banks stated that the differences would not be sufficient to recognize subspecies by current taxonomic standards, and Schroeder noted that the differences were not consistent with any of the described geographic or genetic delineations between putative subspecies. Schroeder (2008 p. 9) also noted regional behavior differences in strut rate, but stated it was not clear if this variation reflected population-level effects. Finally, the best available genetic information indicates there is no distinction between the putative western and eastern subspecies (Benedict *et al.* 2003, p. 309; Oyler-McCance and Quinn in press, p. 12).

Because the best scientific and commercial information do not support the taxonomic validity of the purported eastern or western subspecies, our analysis of the status of the greater sage-grouse (below) does not address considerations at the scale of subspecies. (See Findings section, below, for our finding on the petition to list the western subspecies of the greater sage-grouse.)

Life History Characteristics

Greater sage-grouse depend on a variety of shrub-steppe habitats throughout their life cycle, and are considered obligate users of several species of sagebrush (e.g., *Artemisia tridentata* ssp. *wyomingensis* (Wyoming big sagebrush), *A. t.* ssp. *vaseyana* (mountain big sagebrush), and *A. t. tridentata* (basin big sagebrush)) (Patterson 1952, p. 48; Braun *et al.* 1976, p. 168; Connelly *et al.* 2000a, pp. 970-972; Connelly *et al.* 2004, p. 4-1; Miller *et al.* in press, p. 1). Greater sage-grouse also use other sagebrush species such as *A. arbuscula* (low sagebrush), *A. nova* (black sagebrush), *A. frigida* (fringed sagebrush), and *A. cana* silver sagebrush (Schroeder *et al.* 1999, pp. 4-5; Connelly *et al.* 2004, p. 3-4). Thus, sage-grouse distribution is strongly correlated with the distribution of sagebrush habitats (Schroeder *et al.* 2004, p. 364). Sage-grouse exhibit strong site fidelity (loyalty to a particular area even when the area is no longer of value) to seasonal habitats, which includes breeding, nesting, brood rearing, and wintering areas (Connelly *et al.* 2004, p. 3-1). Adult sage-grouse rarely switch between these habitats once they have been selected, limiting their adaptability to changes.

During the spring breeding season, male sage-grouse gather together to perform courtship displays on areas called leks. Areas of bare soil, short-grass steppe, windswept ridges, exposed knolls, or other relatively open sites typically serve as leks (Patterson 1952, p. 83; Connelly *et al.* 2004, p. 3-7 and references therein). Leks are often surrounded by denser shrub-steppe cover, which is used for escape, thermal, and feeding cover. The proximity, configuration, and abundance of nesting habitat are key factors influencing lek location (Connelly *et al.*, 1981, and Connelly *et al.*, 2000 b, cited in Connelly *et al.*, in press a, p. 11). Leks can be formed opportunistically at any appropriate site within or adjacent to nesting habitat (Connelly *et al.* 2000a, p. 970), and, therefore, lek habitat availability is not considered to be a limiting factor for sage-grouse (Schroeder 1999, p. 4). Nest sites are selected independent of lek locations, but the reverse is not true (Bradbury *et al.* 1989, p. 22; Wakkinen *et al.* 1992, p. 382). Thus, leks are indicative of nesting habitat.

Leks range in size from less than 0.04 hectare (ha) (0.1 acre (ac)) to over 36 ha (90 ac) (Connelly *et al.* 2004, p. 4-3) and can host from several to hundreds of males (Johnsgard 2002, p. 112). Males defend individual territories within leks and perform elaborate displays with their specialized plumage and vocalizations to attract females for mating. Although males are capable of breeding the first spring after hatch, young males are rarely successful in breeding on leks due to the dominance of older males (Schroeder *et al.* 1999, p. 14). Numerous researchers have observed that a relatively small number of dominant males account for the majority of copulations on each lek (Schroeder *et al.* 1999, p. 8). However, Bush (2009, p. 106) found on average that 45.9 percent (range 14.3 to 54.5 percent) of genetically identified males in a population fathered offspring in a given year, which indicates that males and females likely engage in off-lek copulations. Males do not participate in incubation of eggs or rearing chicks.

Females have been documented to travel more than 20 km (12.5 mi) to their nest site after mating (Connelly *et al.* 2000a, p. 970), but distances between a nest site and the lek on which breeding occurred is variable (Connelly *et al.* 2004, pp. 4-5). Average distance between a female's nest and the lek on which she was first observed ranged from 3.4 km (2.1 mi) to 7.8 km (4.8 mi) in five studies examining 301 nest locations (Schroeder *et al.* 1999 p. 12).

Productive nesting areas are typically characterized by sagebrush with an understory of native grasses and forbs, with horizontal and vertical structural diversity that provides an insect prey base, herbaceous forage for pre-laying and nesting hens, and cover for the hen while she is incubating (Gregg 1991, p. 19; Schroeder *et al.* 1999, p. 4; Connelly *et al.* 2000a, p. 971; Connelly *et al.* 2004, pp. 4-17, 18; Connelly *et al.* in press b, p. 12). Sage-grouse also may use other shrub or bunchgrass species for nest sites (Klebenow 1969, p. 649; Connelly *et al.* 2000a, p. 970; Connelly *et al.* 2004, p. 4-4). Shrub canopy and grass cover provide concealment for sage-grouse nests and young, and are critical for reproductive success (Barnett and Crawford 1994, p. 116; Gregg *et al.* 1994, p. 164; DeLong *et al.*1995, p. 90; Connelly *et al.* 2004, p. 4-4). Published vegetation characteristics of successful nest sites included a sagebrush canopy cover of 15–25 percent, sagebrush heights of 30 to 80 cm (11.8 to 31.5 in.), and grass/forb cover of 18 cm (7.1 in.) (Connelly *et al.* 2000a, p. 977).

Sage-grouse clutch size ranges from 6 to 9 eggs with an average of 7 eggs (Connelly *et al.* in press a, pp. 14-15). The likelihood of a female nesting in a given year averages 82 percent in eastern areas of the range (Alberta, Montana, North Dakota, South Dakota, Colorado, Wyoming) and 78 percent in western areas of the range (California, Nevada, Idaho, Oregon, Washington, Utah) (Connelly *et al.* in press a, p. 15). Adult females have higher nest initiation rates than yearling females (Connelly *et al.* in press a, p. 15). Nest success (one or more eggs hatching from a nest), as reported in the scientific literature, varies widely (15–86 percent Schroeder *et al.* 1999, p. 11). Overall, the average nest success for sage-grouse in habitats where sagebrush has not been disturbed is 51 percent and for sage-grouse in disturbed habitats is 37 percent (Connelly *et al.*, in press a, p. 1).

Re-nesting only occurs if the original nest is lost (Schroeder *et al.* 1999, p. 11). Sage-grouse re-nesting rates average 28.9 percent (based on 9 different studies) with a range from 5 to 41 percent (Connelly *et al.* 2004. p. 3-11). Other game bird species have much higher re-nesting rates, often exceeding 75 percent. The impact of re-nesting on annual productivity for most sage-grouse populations is unclear and thought to be limited (Crawford *et al.* 2004, p. 4). In north-central Washington State, re-nesting contributed to 38 percent of the annual productivity of that population (Schroeder 1997, p. 937). However, the author postulated that the re-nesting efforts in this population may be greater than anywhere else in the species' range because environmental conditions allow a longer period of time to successfully rear a clutch (Schroeder 1997, p. 939).

Little information is available on the level of productivity (number of chicks per hen that survive to fall) that is necessary to maintain a stable population (Connelly *et al.* 2000b, p. 970). However, Connelly *et al.* (2000b, p. 970, and references therein) suggest that 2.25 chicks per hen are necessary to maintain stable to increasing populations. Long-term productivity estimates of 1.40–2.96 chicks per hen across the species range have been reported (Connelly and Braun 1997, p. 20). Productivity declined slightly after 1985 to 1.21–2.19 chicks per hen (Connelly and Braun 1997, p. 20). Despite average clutch sizes of 7 eggs (Connelly *et al.* in press a, p. 15) due to low chick survival and limited renesting, there is little evidence that populations of sage-grouse produce large annual surpluses (Connelly *et al.* in press a, p. 24).

Hens rear their broods in the vicinity of the nest site for the first 2–3 weeks following hatching (within 0.2–5 km (0.1–3.1 mi)), based on two studies in Wyoming (Connelly *et al.* 2004, p. 4-8). Forbs and insects are essential nutritional components for chicks (Klebenow and Gray 1968, p. 81; Johnson and Boyce 1991, p. 90; Connelly *et al.* 2004, p. 4-9). Therefore, early brood-rearing habitat must provide adequate cover (sagebrush canopy cover of 10 to 25 percent; Connelly *et al.* 2000a, p. 977) adjacent to areas rich in forbs and insects to ensure chick survival during this period (Connelly *et al.* 2004, p. 4-9).

All sage-grouse gradually move from sagebrush uplands to more mesic areas (moist areas such as streambeds or wet meadows) during the late brood-rearing period (3 weeks post-hatch) in response to summer desiccation of herbaceous vegetation (Connelly *et al.* 2000a, p. 971). Summer use areas can include sagebrush habitats as well as riparian areas, wet meadows, and alfalfa fields (Schroeder *et al.* 1999, p. 4). These areas provide an abundance of forbs and insects for both hens and chicks (Schroeder *et al.* 1999, p. 4; Connelly *et al.* 2000a, p. 971). Sage-grouse will use free water although they do not require it since they obtain their water needs from the food they eat. However, natural water bodies and reservoirs can provide mesic areas for succulent forb and insect production, thereby attracting sage-grouse hens with broods (Connelly *et al.* 2004, p. 4-12). Broodless hens and cocks also will use more mesic areas in close proximity to sagebrush cover during the late summer, often arriving before hens with broods (Connelly *et al.* 2004, p. 4-10).

As vegetation continues to desiccate through the late summer and fall, sage-grouse shift their diet entirely to sagebrush (Schroeder *et al.* 1999, p. 5). Sage-grouse depend entirely on sagebrush throughout the winter for both food and cover. Sagebrush stand selection is influenced by snow depth (Patterson 1952, p. 184; Hupp and Braun 1989, p. 827), availability of sagebrush above the snow to provide cover (Connelly *et al.* 2004, pp. 4-13, and references therein) and, in some areas, topography (e.g., elevation, slope and aspect; Beck 1977, p. 22; Crawford *et al.* 2004, p. 5).

Many populations of sage-grouse migrate between seasonal ranges in response to habitat distribution (Connelly *et al.* 2004, p. 3-5). Migration can occur between winter and breeding and summer areas, between breeding, summer, and winter areas, or not at all. Migration distances of up to 161 km (100 mi) have been recorded (Patterson 1952, p.189); however, distances vary depending on the locations of seasonal habitats (Schroeder *et al.* 1999, p. 3). Migration distances for female sage-grouse generally are less than for males (Connelly *et al.* 2004, p. 3-4), but in one study in Colorado, females traveled farther than males (Beck 1977, p. 23). Almost no information is available regarding the distribution and characteristics of migration corridors for sage-grouse (Connelly *et al.* 2004, p. 4-19). Sage-grouse dispersal (permanent moves to other areas) is poorly understood (Connelly *et al.* 2004, p. 3-5) and appears to be sporadic (Dunn and Braun 1986, p. 89). Estimating an ''average'' home range for sage-grouse is difficult due to the large variation in sage-grouse movements both within and among populations. This variation is related to the spatial availability of habitats required for seasonal use, and annual recorded home ranges have varied from 4 to 615 square kilometers (km^2) (1.5 to 237.5 square miles (mi^2)) (Connelly *et al.*, in press a, p. 10).

Sage-grouse typically live between 3 and 6 years, but individuals up to 9 years of age have been recorded in the wild (Connelly *et al.* 2004, p. 3-12). Hens typically survive longer due to a disproportionate impact of predation on leks to males (Schroeder *et al.* 1999, p. 14). Juvenile survival (from hatch to first breeding season) is affected by food availability, habitat quality, harvest, and weather. Based on a review of many field studies, juvenile survival rates range from 7 to 60 percent (Connelly *et al.* 2004, p. 3-12). The variation in juvenile mortality rates may be associated with gender, weather, harvest rates, age of brood female (broods with adult females have higher survival), and with habitat quality (rates increase in poor habitats) (Schroeder *et al.* 1999, p. 14; Connelly *et al.*, in press a, p. 20). The average annual survival rate for male sage-grouse (all ages combined) documented in various studies ranged from 38 to 60 percent and 55 to 75 percent for females (Schroeder *et al.* 1999, p. 14). Higher female survival rates account for a female-biased sex ratio in adult birds (Schroeder 1999, p. 14; Johnsgard 2002, p. 621). The sex ratio of sage-grouse breeding populations varies widely with values between 1.2 and 3 females per male being reported (Connelly *et al.*, in press a, p. 23). Although seasonal patterns of mortality have not been thoroughly examined, over-winter mortality appears to be low (Connelly *et al.* 2000b, p. 229; Connelly *et al.* 2004, p. 9-4). While both males and females are capable of breeding the first spring after hatch, young males are rarely successful due to the dominance of older males on the lek (Schroeder *et al.* 1999, p. 14). Nesting rates of yearling females are 25 percent less than adult females (Schroeder *et al.* 1999, p. 13).

Habitat Description and Characteristics

Sage-grouse are dependent on large areas of contiguous sagebrush (Patterson 1952, p. 48; Connelly *et al.* 2004, p. 4-1; Connelly *et al.* in press a, p. 10; Wisdom *et al.* in press, p. 4), and large-scale characteristics within surrounding landscapes influence sage-grouse habitat selection (Knick and Hanser in press, p. 26). Sagebrush is the most widespread vegetation in the intermountain lowlands in the western United States (West and Young 2000, p. 259) and is considered one of the most imperiled ecosystems in North America (Knick *et al.* 2003, p. 612; Miller *et al.* in press,

p. 4, and references therein). Scientists recognize 14 species and 13 subspecies of sagebrush (Connelly *et al.* 2004, p. 5-2; Miller *et al.* in press, p. 8), each with unique habitat requirements and responses to perturbations (West and Young 2000, p. 259). Sagebrush species and subspecies occurrence in an area is dictated by local soil type, soil moisture, and climatic conditions (West 1983, p. 333; West and Young 2000, p. 260; Miller *et al.* in press, pp. 8-11). The degree of dominance by sagebrush varies with local site conditions and disturbance history. Plant associations, typically defined by perennial grasses, further define distinctive sagebrush communities (Miller and Eddleman 2000, pp. 10-14; Connelly *et al.* 2004, p. 5-3), and are influenced by topography, elevation, precipitation, and soil type. These ecological conditions influence the response and resiliency of sagebrush and their associated understories to natural and human-caused changes.

Sagebrush is typically divided into two groups, big sagebrush and low sagebrush, based on their affinities for different soil types (West and Young 2000, p. 259). Big sagebrush species and subspecies, such as *A. tridentata* ssp. *wyomingensis*, are limited to coarse-textured and/or well-drained sediments. Low sagebrush, such as *A. nova,* typically occur where erosion has exposed clay or calcified soil horizons (West 1983, p. 334; West and Young 2000, p. 261). Reflecting these soil differences, big sagebrush will die if surfaces are saturated long enough to create anaerobic conditions for 2 to 3 days (West and Young 2000, p. 259). Some low sagebrush are more tolerant of occasionally supersaturated soils, and many low sage sites are partially flooded during spring snowmelt. None of the sagebrush taxa tolerate soils with high salinity (West 1983, p. 333; West and Young 2000, p. 257). Sagebrush that provide important annual and seasonal habitats for sage-grouse include three subspecies of big sagebrush (*A. t.* ssp. *wyomingensis, A. t.* ssp. *tridentata* and *A. t.* ssp. *vaseyana*), two low forms of sagebrush (*A. arbuscula* (little sagebrush) and *A. nova*), and *A. cana* ssp. *cana* (Miller *et al.* in press, p. 8).

All species of sagebrush produce large ephemeral leaves in the spring, which persist until reduced soil moisture occurs in the summer. Most species also produce smaller, over-wintering leaves in the late spring that last through summer and winter. Sagebrush have fibrous tap root systems, which allow the plants to draw surface soil moisture, and also to access water deep within the soil profile when surface water is limited (West and Young 2000, p. 259). Most sagebrush flower in the fall. However, during years of drought or other moisture stress, flowering may not occur. Although seed viability and germination are high, seed dispersal is limited. Sagebrush seeds, depending on the species, remain viable for 1 to 3 years. However, Wyoming big sagebrush seeds do not persist beyond the year of their production (West and Young 2000, p. 260).

Sagebrush is long-lived, with plants of some species surviving up to 150 years (West 1983, p. 340). They produce allelopathic chemicals that reduce seed germination, seedling growth, and root respiration of competing plant species and inhibit the activity of soil microbes and nitrogen fixation. Sagebrush has resistance to environmental extremes, with the exception of fire and occasionally defoliating insects (e.g., webworm (*Aroga* spp.); West 1983, p. 341). Most species of sagebrush are killed by fire (West 1983, p. 341; Miller and Eddleman 2000, p. 17; West and Young 2000, p. 259), and historic fire-return intervals were as long as 350 years, depending on sagebrush type and environmental conditions (Baker in press, p. 16). Natural sagebrush recolonization in burned areas depends on the presence of adjacent live plants for a seed source or on the seed bank, if present (Miller and Eddleman 2000, p. 17), and requires decades for full recovery.

Plants associated with the sagebrush understory vary, as does their productivity. Both plant composition and productivity are influenced by moisture availability, soil characteristics, climate, and topographic position (Miller *et al.*, in press, pp. 8-14). Forb abundance can be highly variable from year to year and is largely affected by the amount and timing of precipitation.

Very little sagebrush within its extant range is undisturbed or unaltered from its condition prior to EuroAmerican settlement in the late 1800s (Knick *et al.* 2003, p. 612, and references therein). Due to the disruption of primary patterns, processes, and components of sagebrush ecosystems since EuroAmerican settlement (Knick *et al.* 2003, p. 612; Miller *et al.* in press, p. 4), the large range of abiotic variation, the minimal short-lived seed banks, and the long generation time of sagebrush, restoration of disturbed areas is very difficult. Not all areas previously dominated by sagebrush can be restored because alteration of vegetation, nutrient cycles, topsoil, and living (cryptobiotic) soil crusts has exceeded recovery thresholds (Knick *et al.* 2003, p. 620). Additionally, processes to restore sagebrush ecology are relatively unknown (Knick *et al.* 2003, p. 620). Active restoration activities are often limited by financial and logistic resources and lack of political motivation (Knick *et al.* 2003, p. 620; Miller *et al.* in press, p. 5) and may require decades or centuries (Knick *et al.* 2003, p. 620, and references therein). Meaningful restoration for greater sage-grouse requires landscape, watershed, or eco-regional scale context rather than individual, unconnected efforts (Knick *et al.* 2003, p. 623, and references therein; Wisdom *et al.* in press, p. 27). Landscape restoration efforts require a broad range of partnerships (private, State, and Federal) due to landownership patterns (Knick *et al.* 2003, p. 623; see discussion of landownership below). Except for areas where active restoration is attempted following disturbance (e.g., mining, wildfire), management efforts in sagebrush ecosystems are usually focused on maintaining the remaining sagebrush (Miller *et al.* in press, p. 5; Wisdom *et al.* in press, pp. 26, 30).

Greater sage-grouse require large, interconnected expanses of sagebrush with healthy, native understories (Patterson 1952, p. 9; Knick *et al.* 2003, p. 623; Connelly *et al.* 2004, pp. 4-15; Connelly *et al.* in press a, p. 10; Pyke in press, p. 7; Wisdom *et al.* in press, p. 4). There is little information available regarding minimum sagebrush patch sizes required to support populations of sage-grouse. This is due in part to the migratory nature of some but not all sage-grouse populations, the lack of juxtaposition of seasonal habitats, and differences in local, regional, and range-wide ecological conditions that influence the distribution of sagebrush and associated understories. Where home ranges have been reported (Connelly *et al.* in press a, p. 10 and references therein), they are extremely variable (4 to 615 km^2 range (1.5 to 237.5 mi^2)). Occupancy of a home range also is based on multiple variables associated with both local vegetation characteristics and landscape characteristics (Knick *et al.* 2003, p. 621). Pyke (in press, p. 18) estimated that greater than 4,000 ha (9,884 ac) was necessary for population sustainability. However, he did not indicate whether this value was for migratory or nonmigratory populations, nor if this included juxtaposition of all seasonal habitats. Large seasonal and annual movements emphasize the landscape nature of the greater sage-grouse (Knick *et al.* 2003, p. 624; Connelly *et al.* in press a, p. 10).

Range and Distribution of Sage-Grouse and Sagebrush

Prior to settlement of western North America by European immigrants in the 19th century, greater sage-grouse occurred in 13 States and 3 Canadian provinces—Washington, Oregon, California, Nevada, Idaho, Montana, Wyoming, Colorado, Utah, South Dakota, North Dakota, Nebraska, Arizona, British Columbia, Alberta, and Saskatchewan (Schroeder *et al.* 1999, p. 2; Young *et al.* 2000, p. 445; Schroeder *et al.* 2004, p. 369). Sagebrush habitats that potentially supported sage-grouse occurred over approximately 1,200,483 km² (463,509 mi²) before 1800 (Schroeder *et al.* 2004, p. 366). Currently, greater sage-grouse occur in 11 States (Washington, Oregon, California, Nevada, Idaho, Montana, Wyoming, Colorado, Utah, South Dakota, and North Dakota), and 2 Canadian provinces (Alberta and Saskatchewan), occupying approximately 56 percent of their historical range (Schroeder *et al.* 2004, p. 369). Approximately 2 percent of the total range of the greater sage-grouse occurs in Canada, with the remainder in the United States (Knick in press, p. 14).

Sage-grouse have been extirpated from Nebraska, British Columbia, and possibly Arizona (Schroeder *et al.* 1999, p. 2; Young *et al.* 2000 p. 445; Schroeder *et al.* 2004, p. 369). Current distribution of the greater sage-grouse is estimated at 668,412 km² (258,075 mi²; Connelly *et al.* 2004, p. 6-9; Schroeder *et al.* 2004, p. 369). Changes in distribution are the result of sagebrush alteration and degradation (Schroeder *et al.* 2004, p. 363).

Sage-grouse distribution is associated with sagebrush (Schroeder *et al.* 2004; p. 364), although sagebrush is more widely distributed. However, sagebrush does not always provide suitable habitat due to fragmentation and degradation (Schroeder *et al.* 2004, pp. 369, 372). Very little of the extant sagebrush is undisturbed, with up to 50 to 60 percent having altered understories or having been lost to direct conversion (Knick *et al.* 2003, p. 612). There also are challenges in mapping altered and depleted understories, particularly in semi-arid regions, so maps depicting only sagebrush as a dominant cover type are deceptive in their reflection of habitat quality and, therefore, use by sage-grouse (Knick *et al.* 2003, p. 616). As such, variations in the quality of sagebrush habitats (from either abiotic or anthropogenic events) are reflected by sage-grouse distribution and densities (Figure 1).

[INSERT FIGURE 1 HERE]

Sagebrush occurs in two natural vegetation types that are delineated by temperature and patterns of precipitation (Miller *et al.* in press, p. 7). Sagebrush steppe ranges across the northern portion of sage-grouse range, from British Columbia and the Columbia Basin, through the northern Great Basin, Snake River Plain, and Montana, and into the Wyoming Basin and northern Colorado. Great Basin sagebrush occurs south of sagebrush steppe, and extends from the Colorado Plateau westward into Nevada, Utah, and California (Miller *et al.* in press, p. 7). Other sagebrush types within greater sage-grouse range include mixed-desert shrubland in the Bighorn Basin of Wyoming, and grasslands in eastern Montana and Wyoming that also support *A. cana* and *A. filifolia* (sand sagebrush) (Miller *et al.* in press, p. 7).

Due to differences in the ecology of sagebrush across the range of the greater sage-grouse, the Western Association of Fish and Wildlife Agencies (WAFWA) delineated seven Management Zones (MZs I-VII) based primarily on floristic provinces (Figure 2; Table 1; Stiver *et al.* 2006, p. 1-6). The boundaries of these MZs were delineated based on their ecological and biological attributes rather than on arbitrary political boundaries (Stiver *et al.* 2006, p. 1-6). Therefore, vegetation found within a MZ is similar and sage-grouse and their habitats within these areas are likely to respond similarly to environmental factors and management actions. The WAFWA conservation strategy includes the Gunnison sage-grouse, and the boundary for MZ VII includes its range (Stiver *et al.* 2006, pp. 1-1, 1-8), which does not overlap with the range of the greater sage-grouse.

TABLE 1—THE MANAGEMENT ZONES OF THE GREATER SAGE-GROUSE AS DEFINED BY STIVER *et al.* (2006, PP. 1-7, 1-11).

MZ	STATES AND PROVINCES INCLUDED	FLORISTIC REGION
I	MT, WY, ND, SD, SK, AL	Great Plains
II	ID, WY, UT, CO	Wyoming Basin
III	UT, NV, CA	Southern Great Basin
IV	ID, UT, NV, OR	Snake River Plain
V	OR, CA, NV	Northern Great Basin
VI	WA	Columbia Basin
VII	CO, UT	Colorado Plateau

[INSERT FIGURE 2 HERE]

As stated above, due to the variability in habitat conditions, sage-grouse are not evenly distributed across the range (Figure 1). The MZs I, II, IV, and V encompass the core populations of greater sage-grouse and have the highest reported densities (Table 2, Figures 1, 2; Stiver *et al.* 2006, p. 1-12). The MZ III is composed of lower density populations in the Great Basin, while fewer numbers of more dispersed birds occur in MZ VI (Stiver *et al.* 2006, p. 1-7).

Figure 1—Greater sage-grouse population densities based on average number of males per lek (from Stiver *et al.* 2006, p. 1-12). Darker areas indicate higher breeding population densities.

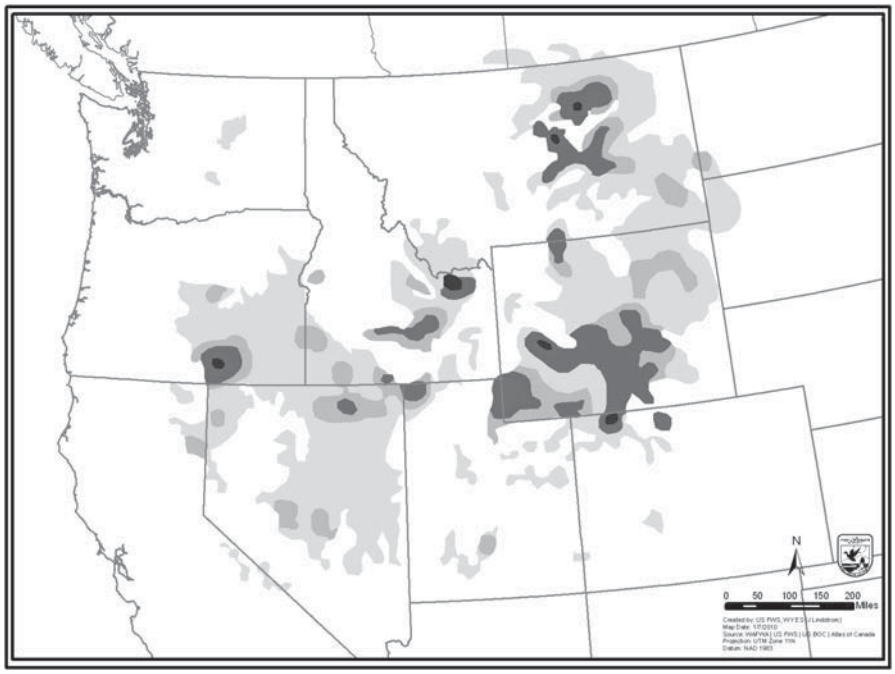


Figure 2—The Management Zones for sage-grouse as identified by Stiver *et al.* (2006, p. 1-11). (Delineation primarily based on floristic provinces and population boundaries.)

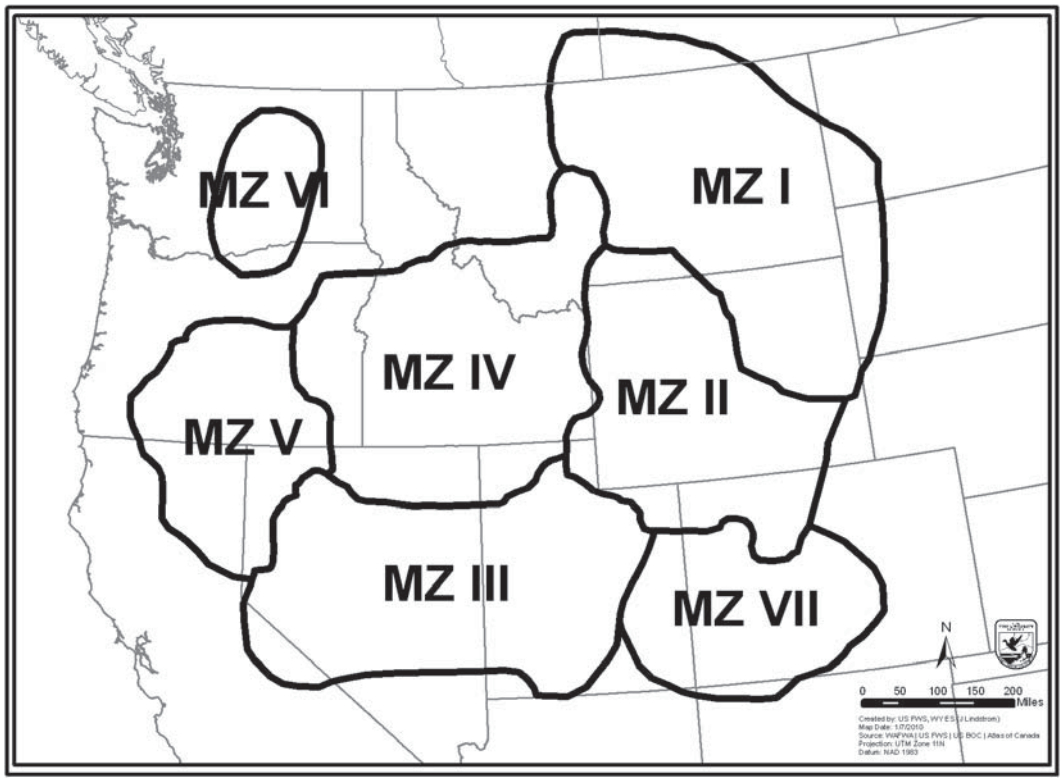


TABLE 2—RELATIVE ABUNDANCE OF GREATER SAGE-GROUSE LEKS, AND NUMBERS OF MALES ATTENDING LEKS BY MANAGEMENT ZONE, BASED ON THE MEAN NUMBER OF INDIVIDUAL LEKS AND MEAN MAXIMUM NUMBER OF MALES ATTENDING LEKS BY MZ DURING 2005–2007.

MZ	Relative Abundance of Leks	Relative Abundance of Males Attending Leks
I	0.17	0.15
II	0.48	0.50
III	0.06	0.07
IV	0.19	0.18
V	0.09	0.10
VI	0.004	0.005
VII	0.003	0.003

Land Ownership of Habitats

Greater sage-grouse extant habitats have multiple surface ownerships, as reflected in Table 3. Most of the habitats occur on Federal surfaces, a reflection of land disposal practices during EuroAmerican settlement of the western United States (Knick in press, pp. 5-10). Lands dominated by sagebrush that were disposed to private ownership typically had deeper soils and greater available water capacity or access to water (valley bottoms), reflecting their capacity for agricultural development or increased grazing activities (Knick in press, p. 15). The lands remaining in Federal ownership were of poorer overall quality. The resulting low productivity on Federal surfaces affects their ability to recover from disturbance (Knick in press, p. 17).

Federal agencies manage almost two-thirds of the sagebrush habitats (Table 3). The Bureau of Land Management (BLM) manages just over half of sage-grouse habitats, while the U.S. Forest Service (USFS) is responsible for management of approximately 8 percent of sage-grouse habitat (Table 3). Other Federal agencies, including the Service, Bureau of Indian Affairs (BIA), Bureau of Reclamation (BOR), National Park Service (NPS), Department of Defense (DOD), and Department of Energy (DOE) also are responsible for sagebrush habitats, but at a much smaller scale (Table 3). State agencies manage approximately 5 percent of sage-grouse habitats.

TABLE 3—PERCENT SURFACE OWNERSHIP OF TOTAL SAGEBRUSH AREA (KM^2 (MI^2)) WITHIN THE SAGE-GROUSE MANAGEMENT ZONES (FROM KNICK IN PRESS, P. 39). OTHER FEDERAL AGENCIES INCLUDE THE SERVICE, BOR, NPS, DOD, AND DOE. MZ VII INCLUDES BOTH GUNNISON AND GREATER SAGE-GROUSE.

Sage-grouse MZ	km^2	mi^2	Sagebrush Management and Ownership					
			BLM Percent	Private Percent	USFS Percent	State Percent	BIA Percent	Other Federal Percent
I Great Plains	50,264	19,407	17	66	2	7	4	3
II Wyoming Basin	108,771	41,996	49	35	4	7	4	1
III Southern Great Basin	92,173	35,588	73	13	10	3	1	0
IV Snake River Plain	134,187	51,810	53	29	11	6	1	0
V Northern Great Basin	65,536	25,303	62	21	10	1	1	6
VI Columbia Basin	12,105	4,674	6	64	2	12	13	3
VII Colorado Plateau	17,534	6,770	42	36	6	6	9	1
TOTALS	480,570	185,549	52	31	8	5	3	1

Population Size

Estimates of greater sage-grouse abundance were mostly anecdotal prior to the implementation of systematic surveys in the 1950s (Braun 1998, p. 139). Early reports suggested the birds were abundant throughout their range, with estimates of historical populations ranging from 1,600,000 to 16,000,000

birds (65 FR 51580, August 24, 2000). However, concerns about extinction were raised in early literature due to market hunting and habitat alteration (Hornaday 1916, pp. 181-185). Following a review of published literature and anecdotal reports, Connelly *et al.* (2004, ES-1-3) concluded that the abundance of sage-grouse has declined from presettlement (defined as 1800) numbers. Most of the historical population changes were the result of local extirpations, which has been inferred from a 44 percent reduction in sage-grouse distribution described by Schroeder *et al.* 2004 (Connelly *et al.* 2004, p. 6-9).

Population numbers are difficult to estimate due to the large range of the species, physical difficulty in accessing some areas of habitat, the cryptic coloration and behavior of hens (Garton *et al.* in press, p. 6), and survey protocols. Problems with inconsistent sampling protocols for lek surveys (e.g., number of times a lek is counted, number of leks surveyed in a year, observer bias, observer experience, time counted) were identified by Walsh *et al.* (2006, pp. 61-64) and Garton *et al.* (in press, p. 6), and many of those problems still persist (Stiver *et al.* 2006, p. 3-1). Additionally, estimating population sizes using lek data is difficult as the relationship of those data to actual population size (e.g., ratio of males to females, percent unseen birds) is usually unknown (WAFWA 2008, p. 3). However, the annual counting of males on leks remains the primary approach to monitor long-term trends of populations (WAFWA 2008, p. 3), and standardized techniques are beginning to be implemented throughout the species' range (Stiver *et al.* 2006, pp. 3-1 to 3-16). The use of harvest data for estimating population numbers also is of limited value since both harvest and the population size on which harvest is based are estimates. Given the limitations of these data, States usually rely on a combination of actual counts of birds on leks and harvest data to estimate population size. Estimates of populations by State, generated from a variety of data sources, are provided in Table 4.

TABLE 4—SAGE-GROUSE POPULATION ESTIMATES BASED ON DATA FROM STATE WILDLIFE AGENCIES.

Location	Data Year	Source	Estimated Population
CA/NV	2004	California/Nevada Sage-grouse Conservation Team (2004, p. 26)	88,000
CO	2008	2007 CO Conservation plan, based on adjusted male lek counts (count + 1.6 multiplier, sex ratio females:males) (Colorado Greater Sage-grouse Steering Committee 2008, p. 56)	22,646
ID	2007	Calculated based on assumption of 5% of population is harvested (Service, unpublished data)	98,700
MT	2007	Calculated based on assumption of 5% of population is harvested (Service, unpublished data)	62,320
ND	2007	2008 lek counts adjusted (assumes 75% of males counted at lek, & sex ratio of 2:1) (A. Robinson, NDGFD, pers. comm., 2008)	308
OR	2003	2003 Oregon Conservation Plan Estimate (Hagen 2005, p. 27)	40,000
SD	2007	South Dakota Game and Fish web page (last updated in 2007)	1,500
UT	2002	Utah Division of Wildlife Resources (2002, p. 13)	12,999
WA	2003	Washington Division of Fish and Wildlife (Stinson *et al.* 2004, p. 21)	1,059
WY	2007	Calculated based on assumption of 5% of population is harvested (Service, unpublished data)	207,560
Canada	2006	Government of Canada 2010	450

Braun (1998, p. 141) estimated that the minimum 1998 rangewide spring population numbered about 157,000 sage-grouse, derived from numbers of males counted on leks. The same year, State wildlife agencies within the range of the species estimated the population was at least 515,000 based on lek counts and harvest data (Warren 2008, pers. comm.). In 2000, we estimated the rangewide abundance of sage-grouse was between a minimum of 100,000 (taken from Braun 1998, p. 141) up to 500,000 birds (based on harvest data from Idaho, Montana, Oregon, and Wyoming, with the assumption that 10 percent of the population is typically harvested) (65 FR 51578, August 24, 2000). In 2003, based on increased lek survey efforts, Connelly *et al.* (2004, p. 13-5) concluded that rangewide population numbers were likely much greater than the 157,000 estimated by Braun (1998, p. 141), but they were unable to generate a rangewide population estimate. Garton *et al.*, (in press, p. 2) estimated a rangewide minimum of 88,816 males counted on leks in 2007, the last year data were formally collated and reported. Estimates of historical populations range from 1,600,000 to 16,000,000 birds (65 FR 51580).

Population Trends

Although population numbers are difficult to estimate, the long-term data collected from counting males on leks provides insight to population trends. Periods of historical decline in sage-grouse abundance occurred from the late 1800s to the early-1900s (Hornaday 1916, pp. 179-221; Crawford 1982, pp. 3-6; Drut 1994, pp. 2-5; WDFW 1995; Braun 1998, p. 140; Schroeder *et al.* 1999, p. 1). Other noticeable declines in sage-grouse populations occurred in the 1920s and 1930s, and then again in the 1960s and 1970s (Connelly and Braun 1997, pp. 3-4; Braun 1998, p. 141). Declines in the 1920s and 1930s were

attributed to hunting, and declines in the 1960s and 1970s were primarily as a result of loss of habitat quality and quantity (Connelly and Braun 1997, p. 2). State wildlife agencies were sufficiently concerned with the decline in the 1920s and 1930s that many closed their hunting seasons and others significantly reduced bag limits and season lengths as a precautionary measure (Patterson 1952, pp. 30-33; Autenrieth 1981, p. 10).

Using lek counts as an index for abundance, Connelly *et al.* (2004, p. 6-71) reported rangewide declines from 1965 through 2003. Declines averaged 2 percent per year from 1965 to 2003. The decline was more dramatic from 1965 through 1985, with an average annual change of 3.5 percent. The rate of decline rangewide slowed to 0.37 percent annually during 1986 to 2003 and some populations increased (Connelly *et al.* 2004, p. 6-71). Based on these analyses, Connelly *et al.* 2004 (p. 6-71) estimated that sage-grouse population numbers in the late 1960s and early 1970s were likely two to three times greater than current numbers (Connelly *et al.* 2004, p. 6-71). Using a statistical population reconstruction approach, Garton *et al.* (in press, p. 67) also demonstrated a pattern of higher numbers of sage-grouse in the late 1960s and early 1970s, which was supported by data from several other sources (Garton *et al.* in press, p. 68).

In 2008, WAFWA conducted new population trend analyses that incorporated an additional 4 years of data beyond the Connelly *et al.* 2004 analysis (WAFWA 2008, entire). Although the WAFWA analyses used different statistical techniques, lek counts also were used. WAFWA results were similar to Connelly *et al.* (2004) in that a long-term population decline was detected during 1965 to 2007 (average 3.1 percent annually; WAFWA 2008, p. 12). WAFWA attributed the decline to the reduction in number of active leks (WAFWA 2008, p. 51). Similar to Connelly *et al.* (2004), the WAFWA analyses determined that the rate of decline lessened during 1985 to 2007 (average annual change of 1.4 percent annually) (WAFWA 2008, p. 58). Garton *et al.* (in press, pp. 68-69) also had similar results. While the average annual rate of decline has lessened since 1985 (3.1 to 1.4 percent), population declines continue and populations are now at much lower levels than in the early 1980's. Therefore, these continuing negative trends at such low relative numbers are concerning regarding long-term population persistence. Similarly, short-term increases or stable trends, while on the surface seem encouraging, do not indicate that populations are recovering but may instead be a function of losing leks and not increases in numbers (WAFWA 2008, p.51). Population stability may also be compromised if cycles in sage-grouse populations (Schroeder *et al.* 1999, p. 15; Connelly *et al.* 2004, p.6-71) are lost, which current analyses suggest, minimizing the opportunities for population recovery if habitat were available (Garton 2009, pers. comm.).

Although the MZs were not formally adopted by WAFWA until 2006, the population trend analyses conducted by Connelly *et al.* (2004) included trend analyses based on the same floristic provinces used to define the zones. While the average annual rate of change was not presented, the results of those analyses indicated long-term declines in greater sage-grouse for MZs I, II, III, IV and VI. Population trends in MZs V and VII were increasing, but the trends were not statistically significant (Connelly *et al.* 2004, p. 6-71; Stiver *et al.* 2006, p. 1-7). WAFWA (2008) and Garton *et al.* (in press) population trend analyses did consider MZs. The WAFWA (2008, pp. 13-27) and Garton *et al.* (in press, pp. 22-62) reported that MZs I through VI had negative population trends from 1965 to 2007. All population trend analyses had similar results, with the exception of MZ VII (Table 5). However, this MZ has one of the highest proportions of inactive leks (Garton *et al.* in press, p. 65), which may imply that male numbers on the remaining leks are increasing as birds relocate. The analysis of this MZ also suffered from small sample sizes and therefore large confidence intervals (Garton *et al.* in press, p. 217), so the trend may not actually reflect the population status.

TABLE 5—LONG-TERM POPULATION TREND ESTIMATES FOR GREATER SAGE-GROUSE MANAGEMENT ZONES.

MZ	States and Provinces Included	Population Trend Estimates 1965-2003* (Connelly *et al.* 2004)	Population Trend Estimates Based on Annual Rates of Change (%) 1965-2007(WAFWA 2008)	Population Trend Estimates Based on Annual Rates of Change (%) 1965–2007 (Garton *et al.* in press)
I	MT, WY, ND, SD, SK, AL	Long-term decline	-2.9	-2.9
II	ID, WY, UT, CO	Long-term decline	-2.7	-3.5
III	UT, NV, CA	Long-term decline	-2.2	-10**
IV	ID, UT, NV, OR	Long-term decline	-3.8	-4**
V	OR, CA, NV	Change statistically undetectable	-3.3	-2**
VI	WA	Long-term decline	-5.1	-6.5
VII	CO, UT	Change statistically undetectable	No detectable trend	+34**

*Average annual rate of change was not reported.
**Due to sample inadequacies for the statistical analyses used, only data from 1995 to 2007 could be used.

Differences in the MZ trends observed between the three analyses are minimal, with the exception of MZs III, V, and VII. While the results of Connelly *et al.* (2004) and WAFWA (2008) were similar for MZ III, Garton *et al.* (in press) showed a larger rate of decline. This difference may be due to the shortened time period (12 versus 42 years) Garton *et al.* (in press) used for the analyses because some earlier data were not suitable for the statistical procedures used. This increased rate of decline was not observed for MZ IV where Garton *et al.*'s (in press) analyses also spanned only 12 years, suggesting that declines in MZ III may have recently accelerated. No explanation was offered by WAFWA

(2008) about the difference between their analyses and Connelly *et al.* (2004) for MZ V. However, Garton *et al.* (in press) results are similar to WAFWA for the same area.

The difference in the annual rate of change between Connelly *et al.* (2004) and WAFWA (2008) as compared to Garton *et al.* (in press) for MZ VII is substantial (Table 5). Garton *et al.* (in press) did not offer an explanation of this difference, but Connelly *et al.* (2004; as cited by (Stiver *et al.* 2006, p. 1-7)) indicated population trends were increasing in this MZ, although those increases were not statistically significant. However, Garton *et al.* (in press, pp. 62-63) reported that the number of leks in MZ VII declined by 39 percent during the same analysis period. The increase in annual rate of change may simply reflect increases on remaining leks as habitat became more limited.

In addition to calculating annual rates of change by MZ, Garton *et al* (in press) also reported the percent change in number of males per lek from 1965 to 2007, the percent change of active leks from 1965 to 2007, and minimum male population estimates in 2007 (Table 6). The percent change in number of males per lek and the percent change in active leks reflect population declines, and possibly habitat loss in all MZs.

TABLE 6—MINIMUM MALE GREATER SAGE-GROUSE POPULATION ESTIMATES IN 2007, PERCENT CHANGE IN NUMBER OF MALES PER LEK AND PERCENT CHANGE IN NUMBER OF ACTIVE LEKS BETWEEN 1965 AND 2007 BY MANAGEMENT ZONE (FROM GARTON *et al.* IN PRESS, PP. 22-64).

MZ	Min Population Est in 2007 (# of males)	Percent Change in # of Males per Lek (1965–2007)	Percent Change of Active Leks (1965–2007)
I	14,814	-17	-22
II	42,429	-30	-7
III	6,851	-24	-16 ***
IV	15,761	-54	-11***
V	6,925	-17**	-21**
VI	315	-76	-57
VII	241	-13	-39*

*1995 to 2007 — due to sample sizes, only data from this time period were used.
**1985 to 2007 — due to sample sizes, only data from this time period were used.
***1975 to 2007 — due to sample sizes, only data from this time period were used.

In summary, since neither presettlement nor current numbers of sage-grouse are accurately known, the actual rate and magnitude of decline since presettlement times is uncertain. However, three groups of researchers using different statistical methods (but the same lek count data) concluded that rangewide greater sage-grouse have experienced long-term population declines in the past 43 years, with that decline lessening in the past 22 years. Many of these declines are the result of loss of leks (WAFWA 2008, p. 51), indicating either a direct loss of habitat or habitat function (Connelly and Braun 1997, p. 2). A recent increase in the annual rate of change for MZ VII may simply be an anomaly of small population numbers, as other indicators suggest this area is suffering habitat losses. A delayed response of sage-grouse to changes in carrying capacity was identified by Garton *et al.* (in press, p.71).

Connectivity

Greater sage-grouse are a landscape-scale species, requiring large expanses of sagebrush to meet all seasonal habitat requirements. The loss of habitat from fragmentation and conversion decreases the connectivity between seasonal habitats potentially resulting in the loss of the population (Doherty *et al.* 2008, p. 194). Loss of connectivity also can increase population isolation (Knick and Hanser in press, p. 4, and references therein) and, therefore, the probability of loss of genetic diversity and extirpation from stochastic events.

Analyses of connectivity of greater sage-grouse across the sagebrush landscape were conducted by Knick and Hanser (in press, entire). Knick and Hanser (in press, p. 29) found that the average movement between population centers (leks) of sage-grouse rangewide was 16.6 km (10.3 mi), with a standard deviation of 7.3 km (4.5 mi). Leks within 18 km (11.2 mi) of each other had common features when compared to leks further than this distance (Knick and Hanser in press, p. 17). Therefore, they used a distance of 18 km (11.2 mi) between leks to assess connectivity (movement between populations), but cautioned that this distance may not accurately reflect genetic flow, or lack thereof, between populations (Knick and Hanser in press, p. 28). Genetic evidence suggests that exchange of individual birds has not been restricted, although there is a gradation of allelic frequencies across the species' range (Oyler-McCance and Quinn, in press, p. 14). This result suggests that widespread movements (e.g., across several States) are not occurring.

Population linkages primarily occurred within MZs, and connectivity between MZs was limited, with the exception of MZs I (Great Plains) and II (Wyoming Basin). Within MZs, the Wyoming Basin (MZ II) had the highest levels of connectivity, followed by MZ IV (Snake River Plain) and MZ I (Great Plains) (Knick and Hanser in press, p. 18). The MZ VI (Columbia Basin) and VII (Colorado Plateau) had the least internal connectivity, suggesting there was limited dispersal between leks and an existing relatively high degree of isolation (Knick and Hanser in press, p. 18). Areas along the edges of the sage-grouse range (e.g., Columbia Basin, Bi-State area) are currently isolated from other sage-grouse populations (Knick and Hanser in press, p. 28).

Connectivity between sage-grouse MZs and the populations within them declined across all three analysis periods examined: 1965–1974, 1980–1989, and 1998–2007. The decline in connectivity was due to the loss of leks and reduced population size (Knick and Hanser in press, p. 29). Historic leks with low connectivity also were lost

(Knick and Hanser in press, p. 20), suggesting that current isolation of leks by distance (including habitat fragmentation) will likely result in their future loss (Knick and Hanser in press, p. 28). Small decreases in lek connectivity resulted in large increases in probability of lek abandonment (Knick and Hanser, in press, p. 29). Therefore, maintaining habitat connectivity and sage-grouse population numbers are essential for sage-grouse persistence.

Sagebrush distribution was the most important factor in maintaining connectivity (Knick and Hanser in press, p. 32). This result suggests that any activities that remove or fragment sagebrush habitats will contribute to loss of connectivity and population isolation. This conclusion is consistent with research from both Aldridge *et al.* (2008, p. 988) and Wisdom *et al.* (in press, p. 13), which independently identified the proximity of sagebrush patches and area in sagebrush cover as the best predictors for sage-grouse presence.

Summary of Information Pertaining to the Five Factors

Section 4 of the Act (16 U.S.C. 1533) and implementing regulations (50 CFR part 424) set forth procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. In making this finding, we summarize below information regarding the status and threats to the greater sage-grouse in relation to the five factors provided in section 4(a)(1) of the Act. Under section (4) of the Act, we may determine a species to be endangered or threatened on the basis of any of the following five factors: (A) Present or threatened destruction, modification, or curtailment of habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. Our evaluation of threats is based on information provided in the petition, available in our files, and other sources considered to be the best scientific and commercial information available, including published and unpublished studies and reports.

Differences in ecological conditions within each MZ affect the susceptibility of these areas to the various threats facing sagebrush ecosystems and its potential for restoration. For example, *Centaurea diffusa* (diffuse knapweed), an exotic annual weed, is most competitive within shrub-grassland communities where antelope bitterbrush is dominant (MZ VI), and *Bromus tectorum* (cheatgrass) is more dominant in areas with minimal summer precipitation (MZs III and V) (Miller *et al.*, in press, pp. 20-21). Therefore, we stratify our analyses by these MZs because they represent zones within which ecological variation is less than what it would be across the range of the species. This approach allows us to better assess the impact and benefits of actions occurring across the species' range and in turn more accurately assess the status of the species.

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range.

Several factors are contributing to the destruction, modification, or curtailment of the greater sage-grouse's habitat or range. Several recent studies have demonstrated that sagebrush area is one of the best landscape predictors of greater sage-grouse persistence (Aldridge *et al.* 2008, p. 987; Doherty *et al.* 2008, p. 191; Wisdom *et al.*, in press, p. 17). Sagebrush habitats are becoming increasingly degraded and fragmented due to the impacts of multiple threats, including direct conversion, urbanization, infrastructure such as roads and powerlines built in support of several activities, wildfire and the change in wildfire frequency, incursion of invasive plants, grazing, and nonrenewable and renewable energy development. Many of these threat factors are exacerbated by the effects of climate change, which may influence long-term habitat trends.

Habitat Conversion for Agriculture

Sagebrush is estimated to have covered roughly 120 million ha (296 million ac; Schroeder *et al.* 2004, p. 365) in western North America, but large portions of that area have been cultivated for the production of agricultural crops (e.g., potatoes, wheat; Schroeder *et al.* 1999, p. 16; 2000, p. 11). Western rangelands were converted to agricultural lands on a large scale beginning with the series of Homestead Acts in the 1800s (Braun 1998, p. 142, Hays *et al.* 1998, p. 26; Knick in press, p. 4; Knick *et al.* in press, p. 11), especially where suitable deep soil terrain and water were available (Rogers 1964, p.13, Schroeder and Vander Haegen, 2009, in press, p. 3). Connelly *et al.* (2004, p. 5-55) estimated that 24.9 million ha (61.5 million ac) within the sage-grouse conservation area (SGCA) used for their assessment area (historic range of Gunnison and greater sage-grouse plus a 50-km (31-mi) buffer) for sage-grouse is now comprised of agricultural lands, although some areas within the species' range are not sagebrush habitat, and the SGCA is larger than the sage-grouse current distribution. An estimated 10 percent of sagebrush steppe that existed prior to EuroAmerican settlement has been converted to agriculture (Knick *et al.* in press, p. 13). The remaining 90 percent is largely unsuited for agriculture because irrigation is not considered to be feasible, topography and soils are limiting, or temperatures are too extreme for many crops (West 1996 cited in Knick *et al.* in press, p. 13).

Habitat conversion results in loss of habitat available for sage-grouse use. The actual effect of this loss depends on the amount of sagebrush lost, the type of seasonal habitat affected, and the arrangement of habitat lost (large blocks or small patches) (Knick *et al.* in press, p. 15). Direct impacts to sage-grouse depend on the timing of conversion (e.g., loss of nests, eggs). Indirect effects of agricultural activities adjoining sagebrush habitats include increased predation with a resulting reduced sage-grouse nest success (Connelly *et al.* 2004, p. 7-23), increased human presence, and habitat fragmentation.

To estimate the area possibly influenced by these indirect effects, Knick *et al.* (in press, p. 13) applied a ''high effective buffer'' out to 6.9 km (4.3 mi) from agricultural lands, based on foraging distances of synathropic (ecologically associated with humans) predators (e.g. red foxes (*Vulpes vulpes*) and ravens (*Corvus corax*)). Given the distribution of agricultural activities across the sagebrush range, nearly three quarters of all sagebrush within range of sage-grouse has been influenced by agricultural activities (falls within the high effective buffer) (Knick *et al.* in press, p. 13). This influence includes foraging distances for synathropic predators (Leu *et al.* 2008, p. 1120; Knick *et al.* in press, p. 13), and associated features such as irrigation ditches. Extensive conversion of sagebrush to agriculture within a landscape has decreased abundance of sage-grouse in many portions of their range (Knick and Hanser in press, p. 30, and references therein).

Soil associations have resulted in disproportionate levels of habitat conversion across different sagebrush communities. For example, *Artemisia tridentata* ssp. *vaseyana* is found at lower elevations, in soils that retain moisture 2 to 4 weeks longer than in well-drained, but dry and higher elevation soils typical of *A. t.* ssp. *wyomingensis* locations. Therefore, sagebrush communities dominated by basin big sagebrush (*A. t.* ssp. *tridentata)* have been converted to agriculture more

extensively than have communities on poorer soil sites (Winward 2004, p. 29) (also see discussion below).

Large losses of sagebrush shrub-steppe habitats due to agricultural conversion have occurred in some areas within the range of the greater sage-grouse. This loss has been especially apparent in the Columbia Basin of the Northwest (MZ VI), the Snake River Plain of Idaho (MZ IV) (Schroeder *et al.* 2004, p. 370), and the Great Plains (MZ I) (Knick *et al.* in press, p. 13). Hironaka *et al.* (1983, p. 27) estimated that 99 percent of basin big sagebrush habitat in the Snake River Plain has been converted to cropland. Between 1975 and 1992 alone, 29,762 ha (73,543 ac) of sagebrush habitat were converted to cropland on the Upper Snake River Plain, a 74-percent increase in cropland (Leonard *et al.* 2000, p. 268). The loss of this primarily winter sage-grouse habitat is significantly related to subsequent sage-grouse declines (Leonard *et al.* 2000, p. 268).

Prior to EuroAmerican settlement in the 19th century, Washington had an estimated 42 million ha (103.8 million ac) of shrub-steppe (Connelly *et al.* 2004, p. 7-22). Approximately 60 percent of the original shrub-steppe habitat in Washington has been converted to primarily agricultural uses (Dobler 1994, p. 2). Deep soils supporting shrub-steppe communities in Washington within sage-grouse range continue to be converted to agricultural uses (Vander Haegen *et al.* 2000, p. 1156), resulting in habitat loss. Agriculture is the dominant land cover within sagebrush areas of Washington (42 percent) and Idaho (19 percent) (Miller *et al.*, in press, p. 18). In north-central Oregon (MZ V), approximately 2.6 million ha (6.4 million ac) of habitat were converted for agricultural purposes, essentially eliminating sage-grouse from this area (Willis *et al.* 1993, p. 35). More broadly, across the interior Columbia Basin of southern Idaho, northern Utah, northern Nevada, eastern Oregon (MZ IV), and Washington, approximately 6 million ha (14.8 million ac) of shrub-steppe habitat has been converted to agricultural crops (Altman and Holmes 2000, p. 10).

Braun concluded that development of irrigation projects to support agricultural production in areas where soils were sufficient to support agriculture, in some cases conjointly with hydroelectric dam construction, has resulted in additional sage-grouse habitat loss (Braun 1998, p. 142). The reservoirs formed by these projects impacted native shrub-steppe habitat adjacent to the rivers in addition to supporting the irrigation and direct conversion of shrub-steppe lands to agriculture. The projects precipitated conversion of large expanses of upland shrub-steppe habitat in the Columbia Basin for irrigated agriculture (65 FR 51578). The creation of these reservoirs also inundated hundreds of kilometers of riparian habitats used by sage-grouse broods (Braun 1998, p. 144). However, other small and isolated reclamation projects (4,000 to 8,000 ha (10,000 to 20,000 ac)) were responsible for three-fold localized increases in sage-grouse populations (Patterson 1952, pp. 266-274) by providing water in a semiarid environment, which provided additional insect and forb food resources (e.g., Eden Reclamation Project in Wyoming). Benefits of providing water through agricultural activities may now be negated due to the threat of West Nile virus (WNv) (Walker *et al.* 2004, p. 4).

Five percent of the areas occupied by Great Basin sagebrush have been converted to agriculture, urban or industrial areas (MZs III and IV) (Miller *et al.* in press, p. 18). Five percent has also been converted in the wheatgrass-needlegrass-shrubsteppe (MZ II, primarily in north-central Wyoming) (Miller *et al.*, in press, p. 18). In sagebrush-steppe habitats, 14 percent of sagebrush habitats had been converted to agriculture, urban or industrial activities (MZs II, IV, V, and VI) (Miller *et al.*, in press, pp. 17-18). Nineteen percent of the Great Plains area (MZ I) has been converted to agriculture (Knick *et al.* in press, p. 13). Conversions for sagebrush habitat types by State are detailed in Table 7.

TABLE 7—CURRENT SAGEBRUSH-STEPPE HABITAT AND AGRICULTURAL LANDS WITHIN GREAT BASIN SAGEBRUSH (AS DERIVED FROM LANDFIRE 2006 VEGETATION COVERAGE) (FROM MILLER *et al.* IN PRESS, PP. 17-18).

State	Percent Sagebrush	Percent Agriculture
Washington	23.7	42.4
Montana	56.2*	7.5*
Wyoming	66.0*	3.4*
Idaho	55.0	18.6
Oregon	64.5	8.6
Nevada	58.7	1.3
Utah	37.6	9.7
California	49.8	8.0
Colorado	40.6*	11.8*
TOTAL	55.4	10.0

*Analyses did not include sagebrush lands in the eastern portions of Colorado, Montana, and Wyoming.

Aldridge *et al.* (2008, pp. 990-991) reported that sage-grouse extirpations were more likely to occur in areas where cultivated crops exceeded 25 percent. Their results supported the conclusions of others (e.g., Schroeder 1997, p. 934; Braun 1998, p. 142; Aldridge and Brigham 2003, p. 30) that extensive cultivation and fragmentation of native habitats have been associated with sage-grouse population declines. Wisdom *et al.* (in press, p. 4) identified environmental factors associated with the regional extirpation of sage-grouse. Areas still occupied by sage-grouse have

three times less area in agriculture and a mean human density 26 times lower than extirpated areas (Wisdom *et al.*, in press, p. 13). While sage-grouse may forage on agricultural crops (see discussion below), they avoid landscapes dominated by agriculture (Aldridge *et al.* 2008, p. 991). Conversions to croplands in southern Idaho have resulted in isolation of sagebrush-dominated landscapes into less productive regions north and south of the Snake River Plain (Knick *et al.* 2003, p. 618). Therefore, formerly continuous populations in this area are now disconnected (Knick and Hanser in press, p. 52).

Sagebrush habitat continues to be converted for both dryland and irrigated crop production (Montana Farm Services Agency (FSA) in litt, 2009; Braun 1998, p. 142; 65 FR 51578, August 24, 2000). The increasing value of wheat and corn crops has driven new conversions in recent years. For example, the acres of sagebrush converted to tilled agriculture in Montana increased annually from 2005 to 2009, with approximately 10,259 ha (25,351 ac) converted, primarily in the eastern two-thirds of the State (MZ I) (Montana FSA in litt, 2009). In addition, in 2008, a single conversion in central Montana totaled between 3,345 and 10,000 ha (10,000 and 30,000 ac) (MZ I) (Hanebury 2008a, pers. comm.). Other large conversions occurred in the same part of Montana in 2008, although these were unquantified (Hanebury 2008b, pers. comm.). We were unable to gather any further information on crop conversions of sagebrush habitats as there are no systematic efforts to collect State or local data on conversion rates in the majority of the greater sage-grouse range (GAO 2007, p. 16).

In addition to crop conversion for traditional crops, recent interest in the development of crops for use as biofuels could potentially impact sage-grouse. For example, the 2008 Farm Bill authorized the Biomass Crop Assistance Program (BCAP), which provides financial incentives to agricultural producers that establish and produce eligible crops for conversion to bioenergy products (U.S. Department of Agriculture (USDA) 2009b, p. 1). Further loss of sagebrush habitats due to BCAP will negatively impact sage-grouse populations. However, currently we have no way of predicting the magnitude of BCAP impacts to sage-grouse (see discussion under Factor D, below).

Although conversion of shrub-steppe habitat to agricultural crops impacts sage-grouse through the loss of sagebrush on a broad scale, some studies report the use of agricultural crops (e.g., alfalfa) by sage-grouse. When alfalfa fields and other croplands are adjacent to extant sagebrush habitat, sage-grouse have been observed feeding in these fields, especially during brood-rearing (Patterson 1952, p. 203; Rogers 1964, p. 53; Wallestad 1971, p. 134; Connelly *et al.* 1988, p.120; Fischer *et al.* 1997, p. 89). Connelly *et al.* (1988, p. 120) reported seasonal movements of sage-grouse to agricultural crops as sagebrush habitats desiccated during the summer. However, use of irrigated crops may not be beneficial to greater sage-grouse if it increases exposure to pesticides (Knick *et al.* in press, p. 16) and WNv (Walker *et al.* 2004, p. 4).

Some conversion of cropland to sagebrush has occurred in former sage-grouse habitats through the USDA's voluntary Conservation Reserve Program (CRP) which pays landowners a rental fee to plant permanent vegetation on portions of their lands, taking them out of agricultural production. In Washington State (Columbia Basin, MZ VI), sage-grouse have declined precipitously in the Columbia Basin largely due to conversion of sagebrush habitats to cropland (Schroeder and Vander Haegen, in press, p. 4). Approximately 599,314 ha (1,480,937 ac) of converted farmland had been enrolled in the CRP, almost all of which was historically shrub-steppe (Schroeder and Vander Haegen in press, p. 5). Schroeder and Vander Haegen (in press, p. 20) found that CRP lands that have been out of production long enough to allow re-establishment of sagebrush and was juxtaposed to a relatively intact shrub-steppe landscape was most beneficial to sage-grouse. There appears to be some correlation with sage-grouse use of CRP and a slight increase in population size in north-central Washington (Schroeder and Vander Haegen in press, p. 21). Schroeder and Vander Haegen (in press, p. 21) concluded that the loss of CRP due to expiration of the program or incentives to produce biofuels would likely severely impact populations in the Columbia Basin.

Although estimates of the numbers of acres enrolled rangewide in CRP (and the number of acres soon to expire from CRP) are available, the extent of cropland conversion to habitats beneficial to sage-grouse (i.e., CRP lands planted with native grasses, forbs, and shrubs) is not known for any other area barring the Columbia Basin. Thus, outside this area, we cannot judge the overall impact of CRP land to sage-grouse persistence.

Direct habitat loss and conversion also occurs via numerous other landscape uses, including urbanization, livestock forage production, road building, and oil pads. These activities are described in greater detail below. Although we were unable to obtain an estimate of the total amount of sagebrush habitats that have been lost due to these activities, they have resulted in habitat fragmentation, as well as habitat loss.

Urbanization

Low densities of indigenous peoples have been present for more than 12,000 years in the historical range of sage-grouse. By 1900, less than 1 person per km^2 (1 person per 0.4 mi^2) resided in 51 percent of the 325 counties within the SGCA, and densities greater than 10 persons per km^2 (10 persons per 0.4 mi^2) occurred in 4 percent of the counties (Connelly *et al.* 2004, p. 7-24). By 2000, counties with less than 1 person per km^2 (1 person per 0.4 mi^2) occurred in 31 percent of the 325 counties and densities greater than 10 persons per km^2 (10 persons per 0.4 mi^2) occurred in 22 percent of the counties (Connelly *et al.* 2004, p. 7-25). Today, the Columbia Basin (MZ VI) has the highest density of humans while the Great Plains (MZ I) and Wyoming Basin (MZ II) have the lowest (Knick *et al.* in press, p. 19). Growth in the Great Plains (MZ I) continues to be slower than other areas. For example, population densities have increased since 1990 by 7 percent in the Great Plains (MZ I), by 19 percent in the Wyoming Basin (MZ II), and by 31 percent in the Colorado Plateau (MZ VII) (Knick *et al.* in press, p. 19).

The dominant urban areas in the sage-grouse range are located in the Bear River Valley of Utah, the portion of Bonneville Basin southeast of the Great Salt Lake, the Snake River Valley of southern Idaho, and the Columbia River Valley of Washington (Rand McNally Road Atlas 2003; Connelly *et al.* 2004, p. 7-25). Overall, approximately 1 percent of the amount of potential sagebrush (estimated historic range) is now covered by lands classified as urban (Miller *et al.*, in press, p. 18).

Knick *et al* (in press, p. 107) examined the influence of urbanization on greater sage-grouse MZs by adding a 6.9-km (4.3-mi) buffer (an estimate of the foraging distances of mammalian and corvid predators of sage-grouse) to the total area of urban land use. Based the estimates using this approach, the Columbia Basin (MZ VI) was influenced the most by urbanization with 48.4 percent of the sagebrush area affected. The Northern Great Basin (MZ V) was influenced least with 12.5 percent affected. Wyoming Basin (MZ II), which

has the majority of sage-grouse in the range, was at 18.4 percent affected.

Since 1950, the western U.S. population growth rate has exceeded the national average (Leu and Hanser in press, p. 4). This growth has led to increases in urban, suburban, and rural development. Rural development has increased especially rapidly in recent decades. For example, the amount of uninhabited area in the Great Basin ecoregion has decreased from 90,000 km² (34,749 mi²) in 1990 to less than 12,000 km² (4,633 mi²) in 2004 (Knick *et al.* in press, p. 20). Urbanization has directly eliminated some sage-grouse habitat (Braun 1998, p. 145). Interrelated effects from urbanization include construction of associated infrastructure (e.g., roads, powerlines, and pipelines) and predation threats from the introduction of domestic pets and increases in predators subsidized by human activities. In particular, municipal solid waste landfills (landfills) and roads have been shown to contribute to increases in common raven (*Corvus corax*) populations (Knight *et al.* 1993 p. 470; Restani *et al.* 2001, p. 403; Webb *et al.* 2004, p. 523). Ravens are known to be an important predator on sage-grouse nests and have been considered a restraint on sage-grouse population growth in some locations (Batterson and Morse 1948, p. 14; Autenrieth 1981, p. 45; Coates 2007, p. 26). Landfills (and roads) are found in every State within the greater sage-grouse range and a number of these are located within or adjacent to sage-grouse habitat.

Recent changes in demographic and economic trends have resulted in greater than 60 percent of the Rocky Mountain West's counties experiencing rural sprawl where rural areas are outpacing urban areas in growth (Theobald 2003, p. 3). In some Colorado counties, up to 50 percent of sage-grouse habitat is under rural subdivision development, and an estimated 3 to 5 percent of all sage-grouse historical habitat in Colorado has already been converted into urban areas (Braun 1998, p. 145). We are unaware of similar estimates for other States within the range of the greater sage-grouse and, therefore, cannot determine the effects of this factor on a rangewide basis. Rural development has increasingly taken the form of low-density (approximately 6 to 25 homes per km² (6 to 25 homes per 0.4 mi²)) home development or exurban growth (Hansen *et al.* 2005, p. 1894). Between 1990 and 2000, 120,000 km² (46,332 mi²) of land were developed at exurban densities nationally (Theobald 2001, p. 553). However, this value includes development nationwide, and we are unable to report values specifically for sagebrush habitats. However, within the Great Basin (including California, Idaho, Nevada, and Utah), human populations have increased 69 percent and uninhabited areas declined by 86 percent between 1990 and 2004 (Leu and Hanser in press, p. 19). Similar to higher density urbanization, exurban development has the potential to negatively affect sage-grouse populations through fragmentation or other indirect habitat loss, increased infrastructure, and increased predation.

In modeling sage-grouse persistence, Aldridge *et al.* (2008, pp. 991-992) found that the density of humans in 1950 was the best predictor of sage-grouse extirpation among the human population metrics considered (including increasing human population growth). Sage-grouse extirpation was more likely in areas having a moderate human population density of at least 4 people per km² (4 people per 0.4 mi²). Increasing human populations were not a good predictor of sage-grouse persistence, most likely because much of the growth occurred in areas that are already no longer suitable for sage-grouse. Aldridge *et al.* (2008, p. 990) also reported that, based on their models, sage-grouse require a minimum of 25 percent sagebrush for persistence in an area. A high probability of persistence required 65 percent sagebrush or more. This result is similar to the results by Wisdom *et al.* (in press, p. 18) who reported that human density was 26 times greater in extirpated sage-grouse areas than in currently occupied range. Therefore, human population growth that results in exurban development in sagebrush habitats will reduce the likelihood of sage-grouse persistence in the area. Given the current demographic and economic trends in the Rocky Mountain West, we believe that rates of urbanization will continue increasing, resulting in further habitat fragmentation and degradation and decreasing the probability of long-term sage-grouse persistence.

Infrastructure in Sagebrush Habitats

Habitat fragmentation is the separation or splitting apart of previously contiguous, functional habitat components of a species. Fragmentation can result from direct habitat losses that leave the remaining habitat in noncontiguous patches, or from alteration of habitat areas that render the altered patches unusable to a species (i.e., functional habitat loss). Functional habitat losses include disturbances that change a habitat's successional state or remove one or more habitat functions; physical barriers that preclude use of otherwise suitable areas; and activities that prevent animals from using suitable habitat patches due to behavioral avoidance.

Sagebrush communities exhibit a high degree of variation in their resistance and resilience to change, beyond natural variation. Resistance (the ability to withstand disturbing forces without changing) and resilience (the ability to recover once altered) generally increase with increasing moisture and decreasing temperatures, and also can be linked to soil characteristics (Connelly *et al.* 2004, p. 13-6). However, most extant sagebrush habitat has been altered since European immigrant settlement of the West (Baker *et al.* 1976, p. 168; Braun 1998, p. 140; Knick *et al.* 2003, p. 612; Connelly *et al.* 2004, p. 13-6), and sagebrush habitat continues to be fragmented and lost (Knick *et al.* 2003, p. 614) through the factors described below. The cumulative effects of habitat fragmentation have not been quantified over the range of sagebrush and most fragmentation cannot be attributed to specific land uses (Knick *et al.* 2003, p. 616). However, in large-scale analysis of the collective effect of anthropogenic features (or the ''human footprint'') in the western United States, Leu *et al.* (2008, p. 1130) found that 13 percent of the area was affected in some way by anthropogenic features (i.e., fragmentation). Areas with the lowest ''human footprint'' (i.e., no to slight development or use) experienced above-average human population growth between 1990 and 2000. There is significant evidence these areas will experience increasing habitat fragmentation in the future (Leu *et al.* 2008, p. 1133). Although the area covered by these estimates includes all western states, we believe the general points regarding effects of anthropogenic features apply to sage-grouse habitat.

Fragmentation of sagebrush habitats has been cited as a primary cause of the decline of sage-grouse populations because the species requires large expanses of contiguous sagebrush (Patterson 1952, pp. 192-193; Connelly and Braun 1997, p. 4; Braun 1998, p. 140; Johnson and Braun 1999, p. 78; Connelly *et al.* 2000a, p. 975; Miller and Eddleman 2000, p. 1; Schroeder and Baydack 2001, p. 29; Johnsgard 2002, p. 108; Aldridge and Brigham 2003, p. 25; Beck *et al.* 2003, p. 203; Pedersen *et al.* 2003, pp. 23-24; Connelly *et al.* 2004, p. 4-15; Schroeder *et al.* 2004, p. 368; Leu *et al.* in press, p. 19). The negative effects of habitat fragmentation have been well documented in numerous bird species, including some shrub-

steppe obligates (Knick and Rotenberry 1995, pp. 1068-1069). However, prior to 2005, detailed data to assess how fragmentation influences specific greater sage-grouse life-history parameters such as productivity, density, and home range were not available. More recently, several studies have documented negative effects of fragmentation as a result of oil and gas development and its associated infrastructure (see discussion of Energy Development below) on lek persistence, lek attendance, winter habitat use, recruitment, yearling annual survival rate, and female nest site choice (Holloran 2005, p. 49; Aldridge and Boyce 2007, pp. 517-523; Walker *et al.* 2007a, pp. 2651-2652; Doherty *et al.* 2008, p. 194). Wisdom *et al.* (in press, p. 18) reported that a variety of human developments, including roads, energy development, and other factors that contribute to habitat fragmentation have contributed to or been associated with sage-grouse extirpation. Estimating the impact of habitat fragmentation on sage-grouse is complicated by time lags in response to habitat changes (Garton *et al.*, in press, p. 71), particularly since these long-lived birds will continue to return to altered breeding areas (leks, nesting areas, and early brood-rearing areas) due to strong site fidelity despite nesting or productivity failures (Wiens and Rotenberry 1985, p. 666).

Powerlines

Power grids were first constructed in the United States in the late 1800s. The public demand for electricity has grown as human population and industrial activities have expanded (Manville 2002, p. 5), resulting in more than 804,500 km (500,000 mi) of transmission lines (lines carrying greater than 115,000 volts (115 kilovolts (kV)) by 2002 within the United States (Manville 2002, p. 4). A similar estimate is not available for distribution lines (lines carrying less than 69,000volts (69kV)), and we are not aware of data for Canada. Within the SGCA, Knick *et al.* (*in press*, p. 21) showed that powerlines cover a minimum of 1,089km^2 (420.5 mi).

Due to the potential spread of invasive species and predators as a result of powerline construction the impact from the powerline is greater than the actual footprint. Knick *et al.* (in press, p. 111) estimated these impacts may influence up to 39 percent of all sagebrush in the SGCA. Powerlines can directly affect greater sage-grouse by posing a collision and electrocution hazard (Braun 1998, pp. 145-146; Connelly *et al.* 2000a, p. 974), and can have indirect effects by decreasing lek recruitment (Braun *et al.* 2002, p. 10), increasing predation (Connelly *et al.* 2004, p. 13-12), fragmenting habitat (Braun 1998, p. 146), and facilitating the invasion of exotic annual plants (Knick *et al.* 2003, p. 612; Connelly *et al.* 2004, p. 7-25). In 1939, three adult sage-grouse died as a result of colliding with a telegraph line in Utah (Borell 1939, p. 85). Both Braun (1998, p. 145) and Connelly *et al.* (2000a, p. 974) report that sage-grouse collisions with powerlines occur, although no specific instances were presented. There was also an unpublished observation reported by Aldridge and Brigham (2003, p. 31). In 2009, two sage-grouse died from electrocution after colliding with a powerline in the Mono Basin of California (Gardner 2009, pers. comm.). We were unable to find any other documentation of other collisions or electrocution of sage-grouse resulting from powerlines.

In areas where the vegetation is low and the terrain relatively flat, power poles provide an attractive hunting and roosting perch, as well as nesting stratum for many species of raptors and corvids (Steenhof *et al.* 1993, p. 27; Connelly *et al.* 2000a, p. 974; Manville 2002, p. 7; Vander Haegen *et al.* 2002, p. 503). Power poles increase a raptor's range of vision, allow for greater speed during attacks on prey, and serve as territorial markers (Steenhof *et al.* 1993, p. 275; Manville 2002, p. 7). Raptors may actively seek out power poles where natural perches are limited. For example, within 1 year of construction of a 596-km (372.5-mi) transmission line in southern Idaho and Oregon, raptors and common ravens began nesting on the supporting poles (Steenhof *et al.* 1993, p. 275). Within 10 years of construction, 133 pairs of raptors and ravens were nesting along this stretch (Steenhof *et al.* 1993, p. 275). Raven counts have increased by approximately 200 percent along the Falcon-Gondor transmission line corridor in Nevada within 5 years of construction (Atamian *et al.* 2007, p. 2). The increased abundance of raptors and corvids within occupied sage-grouse habitats can result in increased predation. Ellis (1985, p. 10) reported that golden eagle (*Aquila chryrsaetos*) predation on sage-grouse on leks increased from 26 to 73 percent of the total predation after completion of a transmission line within 200 meters (m) (220 yards (yd)) of an active sage-grouse lek in northeastern Utah. The lek was eventually abandoned, and Ellis (1985, p. 10) concluded that the presence of the powerline resulted in changes in sage-grouse dispersal patterns and caused fragmentation of the habitat.

Leks within 0.4 km (0.25 mi) of new powerlines constructed for coalbed methane development in the Powder River Basin of Wyoming had significantly lower growth rates, as measured by recruitment of new males onto the lek, compared to leks further from these lines, which were presumed to be the result of increased raptor predation (Braun *et al.* 2002, p. 10). Within the SGCA, Connelly *et al.* (2004, p. 7-26) estimated that the area potentially influenced by additional perches for corvids and raptors provided by powerlines, assuming a 5- to 6.9-km (3.1- to 4.3-mi) radius buffer around the perches based on the average foraging distance of these predators, was 672,644 to 837,390 km^2 (259,641 to 323,317 mi^2), or 32 to 40 percent of the SGCA. The actual impact on the area would depend on corvid and raptor densities within the area, the amount of cover to reduce predation risk at sage-grouse nests, and other factors (see discussion in Factor C, below).

The presence of a powerline may fragment sage-grouse habitats even if raptors are not present. Braun (1998, p. 146) found that use of otherwise suitable habitat by sage-grouse near powerlines increased as distance from the powerline increased for up to 600 m (660 yd) and, based on that unpublished data, reported that the presence of powerlines may limit sage-grouse use within 1 km (0.6 mi) in otherwise suitable habitat. Similar results were recorded for other grouse species. Pruett *et al.* (2009, p. 6) found that lesser and greater prairie-chickens (*Tympanuchus pallidicinctus* and *T. cupido*, respectively) avoided otherwise suitable habitat near powerlines. Additionally, both species also crossed powerlines less often than nearby roads, which suggests that powerlines are a particularly strong barrier to movement (Pruett *et al.* 2009, p. 6).

Sage-grouse also may avoid powerlines as a result of the electromagnetic fields (Wisdom *et al.* in press, p. 19). Electromagnetic fields have been demonstrated to alter the behavior, physiology, endocrine systems, and immune function in birds, with negative consequences on reproduction and development (Fernie and Reynolds 2005, p. 135). Birds are diverse in their sensitivities to electromagnetic field exposures, with domestic chickens being very sensitive. Many raptor species are less affected (Fernie and Reynolds 2005, p. 135).

Linear corridors through sagebrush habitats can facilitate the spread of invasive species, such as *Bromus tectorum* (Gelbard and Belnap 2003, pp. 424-426; Knick *et al.* 2003, p. 620;

Connelly *et al.* 2004, p. 1-2). However, we were unable to find any information regarding the amount of invasive species incursion as a result of powerline construction.

Powerlines are common to nearly every type of anthropogenic habitat use, except perhaps some forms of agricultural development (e.g., livestock grazing) and fire. Although we were unable to find an estimate of all future proposed powerlines within currently occupied sage-grouse habitats, we anticipate that powerlines will continue to increase into the foreseeable future, particularly given the increasing development of energy resources and urban areas. For example, up to 8,579 km (5,311 mi) of new powerlines are predicted for the development of the Powder River Basin coal-bed methane field in northeastern Wyoming (BLM 2003) in addition to the approximately 9,656 km (6,000 mi) already constructed in that area. In November 2009, nine Federal agencies signed a Memorandum of Understanding to expedite the building of new transmission lines on Federal lands. If these lines cross sage-grouse habitats, sage-grouse will likely be negatively affected.

Communication Towers

Within sage-grouse habitats, 9,510 new communication towers have been constructed within recent years (Connelly *et al.* 2004, p. 13-7). While millions of birds are killed annually in the United States through collisions with communication towers and their associated structures (e.g., guy wires, lights) (Shire *et al.* 2000, p. 5; Manville 2002, p. 10), most documented mortalities are of migratory songbirds. We were unable to determine if any sage-grouse mortalities occur as a result of collision with communication towers or their supporting structures, as most towers are not monitored and those that are lie outside the range of the species (Kerlinger 2000, p. 2; Shire *et al.* 2000 p. 19). Cellular towers have the potential to cause sage-grouse mortality via collisions, to influence movements through avoidance of a tall structure (Wisdom *et al.* in press, p. 20), or to provide perches for corvids and raptors (Steenhof *et al.* 1993, p. 275; Connelly *et al.* 2004, p. 13-7).

In a comparison of sage-grouse locations in extirpated areas of their range (as determined by museum species and historical observations) and currently occupied habitats, the distance to cellular towers was nearly twice as far from grouse locations in currently occupied habitats than extirpated areas (Wisdom *et al.* in press, p. 13). The results may have been influenced by location as many cellular towers are close to intensive human development. However, such associations with other indicators of development and cellular towers were low (Wisdom *et al.* in press, p. 20). High levels of electromagnetic radiation within 500 m (547 yd) of all towers have been linked to decreased populations and reproductive performance of some bird and amphibian species (Wisdom *et al.* in press, p. 19, and references therein). We do not know if greater sage-grouse are negatively impacted by electromagnetic radiation, or if their avoidance of these structures is a response to increased predation risk.

Fences

Fences are used to delineate property boundaries and for livestock management (Braun 1998, p. 145; Connelly *et al.* 2000a, p. 974). The effects of fencing on sage-grouse include direct mortality through collisions, creation of predator (raptor) and corvid perch sites, the potential creation of predator corridors along fences (particularly if a road is maintained next to the fence), incursion of exotic species along the fencing corridor, and habitat fragmentation (Call and Maser 1985, p. 22; Braun 1998, p. 145; Connelly *et al.* 2000a, p. 974; Beck *et al.* 2003, p. 211; Knick *et al.* 2003, p. 612; Connelly *et al.* 2004, p. 1-2).

More than 1,000 km (625 mi) of fences were constructed annually in sagebrush habitats from 1996 through 2002, mostly in Montana, Nevada, Oregon, and Wyoming (Connelly *et al.* 2004, p. 7-34). Over 51,000 km (31,690 mi) of fences were constructed on BLM lands supporting sage-grouse populations between 1962 and 1997 (Connelly *et al.* 2000a, p. 974). Sage-grouse frequently fly low and fast across sagebrush flats, and fences can create a collision hazard (Call and Maser 1985, p. 22). Thirty-six carcasses of sage-grouse were found near Randolph, Utah, along a 3.2-km (2-mi) fence within 3 months of its construction (Call and Maser 1985, p. 22). Twenty-one incidents of mortality through fence collisions near Pinedale, Wyoming, were reported in 2003 to the BLM (Connelly *et al.* 2004, p. 13-12). A recent study in Wyoming confirmed 146 sage-grouse fence strike mortalities over a 31–month period along a 7.6-km (4.6-mi) stretch of 3-wire BLM range fence (Christiansen 2009).

Not all fences present the same mortality risk to sage-grouse. Mortality risk appears to be dependent on a combination of factors including design of fencing, landscape topography, and spatial relationship with seasonal habitats (Christiansen 2009, unpublished data). Although the effects of direct strike mortality on populations are not understood, fences are ubiquitous across the landscape. In many parts of the sage-grouse range (primarily Montana, Nevada, Oregon, Wyoming) fences exceed densities of more than 2 km/km^2 (1.2 mi/0.4 mi^2; Knick *et al.* in press, p. 32). Fence collisions continue to be identified as a source of mortality for sage-grouse, and we expect this source of mortality to continue into the foreseeable future (Braun 1998, p. 145; Connelly *et al.* 2000a, p. 974; Oyler-McCance *et al.* 2001, p. 330; Connelly *et al.* 2004, p. 7-3).

Fence posts create perching places for raptors and corvids, which may increase their ability to prey on sage-grouse (Braun 1998, p. 145; Oyler-McCance *et al.* 2001, p. 330; Connelly *et al.* 2004, p. 13-12). We anticipate that the effect on sage-grouse populations through the creation of new raptor perches and predator corridors into sagebrush habitats is similar to that of powerlines discussed previously (Braun 1998, p. 145; Connelly *et al.* 2004, p. 7-3). Fences and their associated roads also facilitate the spread of invasive plant species that replace sagebrush plants upon which sage-grouse depend (Braun 1998, p. 145; Connelly *et al.* 2000a, p. 973; Gelbard and Belnap 2003, p. 421; Connelly *et al.* 2004, p. 7-3). Greater sage-grouse avoidance of habitat adjacent to fences, presumably to minimize the risk of predation, effectively results in habitat fragmentation even if the actual habitat is not removed (Braun 1998, p. 145).

Roads

Interstate highways and major paved roads cover approximately 2,500 km^2 (965 mi^2) or 0.1 percent of the SGCA (Knick *et al.* in press, p. 21). Based on applying a 7-km (4.3-mi) buffer to estimate the potential impact of secondary effects from roads, interstates and highways are estimated to influence 851,044 km^2 (328,590 mi^2) or 41 percent of the SGCA. Additionally, secondary paved roads are heavily distributed throughout most of the SGCA, existing at densities of up to greater than 5 km/km^2 (3.1 mi/mi^2). Taken together, 95 percent of all sage-grouse habitats were within 2.5 km (1.5 mi) of a mapped road, and almost no area of sagebrush was greater the 6.9 km (4.3 mi) from a mapped road (Knick *et al.* in press, p. 21).

Impacts from roads may include direct habitat loss, direct mortality, barriers to migration corridors or seasonal habitats, facilitation of predators and spread of invasive vegetative species, and other indirect

influences such as noise (Forman and Alexander 1998, pp. 207-231). Sage-grouse mortality resulting from collisions with vehicles does occur (Patterson 1952, p. 81), but mortalities are typically not monitored or recorded. Therefore, we are unable to determine the importance of this factor on sage-grouse populations. Data regarding how roads affect seasonal habitat availability for individual sage-grouse populations by creating barriers and the ability of greater sage-grouse to reach these areas were not available. Road development within Gunnison sage-grouse (*C. minimus*) habitats impeded movement of local populations between the resultant patches, with grouse road avoidance presumably being a behavioral means to limit exposure to predation (Oyler-McCance *et al.* 2001, p. 330).

Roads can provide corridors for predators to move into previously unoccupied areas. For some mammalian species, dispersal along roads has greatly increased their distribution (Forman and Alexander 1998, p. 212; Forman 2000, p. 33). Corvids also use linear features such as primary and secondary roads as travel routes, expanding their movements into previously unused regions (Knight and Kawashima 1993, p. 268; Connelly *et al.* 2004, p. 12-3). In an analysis of anthropogenic impacts, at least 58 percent of the SGCA had a high or medium estimated presence of corvids (Connelly *et al.* 2004, p. 12-6). Corvids are important sage-grouse nest predators and in a study in Nevada were positively identified via video recorder as responsible for more than 50 percent of nest predations in the study area (Coates 2007, pp. 26-30). Bui (2009, p. 31) documented ravens following roads in oil and gas fields during foraging. Additionally, highway rest areas provide a source of food and perches for corvids and raptors, and facilitate their movements into surrounding areas (Connelly *et al.* 2004, p. 7-25).

The presence of roads increases human access and resulting disturbance effects in remote areas (Forman and Alexander 1998, p. 221; Forman 2000, p. 35; Connelly *et al.* 2004, pp. 7-6 to 7-25). Increases in legal and illegal hunting activities resulting from the use of roads built into sagebrush habitats have been documented (Hornaday 1916, p. 183; Patterson 1952, p. vi). However, the actual current effect of these increased activities on sage-grouse populations has not been determined. Roads also may facilitate access for rangeland habitat treatments, such as disking or mowing (Connelly *et al.* 2004, p. 7-25), resulting in subsequent direct habitat losses. New roads are being constructed to support development activities within the greater sage-grouse extant range. In the Powder River Basin of Wyoming, up to 28,572 km (17,754 mi) of roads to support coalbed methane development are proposed (BLM 2003).

The expansion of road networks contributes to exotic plant invasions via introduced road fill, vehicle transport, and road maintenance activities (Forman and Alexander 1998, p. 210; Forman 2000, p. 32; Gelbard and Belnap 2003, p. 426; Knick *et al.* 2003, p. 619; Connelly *et al.* 2004, p. 7-25). Invasive species are not limited to roadsides, but also encroach into surrounding habitats (Forman and Alexander 1998, p. 210; Forman 2000, p. 33; Gelbard and Belnap 2003, p. 427). In their study of roads on the Colorado Plateau of southern Utah, Gelbard and Belnap (2003, p. 426) found that improving unpaved four-wheel drive roads to paved roads resulted in increased cover of exotic plant species within the interior of adjacent plant communities. This effect was associated with road construction and maintenance activities and vehicle traffic, and not with differences in site characteristics. The incursion of exotic plants into native sagebrush systems can negatively affect greater sage-grouse through habitat losses and conversions (see further discussion in Invasive Plants, below).

Additional indirect effects of roads may result from birds' behavioral avoidance of road areas because of noise, visual disturbance, pollutants, and predators moving along a road. The absence of vegetation in arid and semiarid regions that may buffer these impacts further exacerbates the problem (Suter 1978, p. 6). Male sage-grouse lek attendance was shown to decline within 3 km (1.9 mi) of a methane well or haul road with traffic volume exceeding one vehicle per day (Holloran 2005, p. 40). Male sage-grouse depend on acoustical signals to attract females to leks (Gibson and Bradbury 1985, p. 82; Gratson 1993, p. 692). If noise interferes with mating displays, and thereby female attendance, younger males will not be drawn to the lek and eventually leks will become inactive (Amstrup and Phillips 1977, p. 26; Braun 1986, pp. 229-230).

Dust from roads and exposed roadsides can damage vegetation through interference with photosynthetic activities. The actual amount of potential damage depends on winds, wind direction, the type of surrounding vegetation and topography (Forman and Alexander 1998, p. 217). Chemicals used for road maintenance, particularly in areas with snowy or icy precipitation, can affect the composition of roadside vegetation (Forman and Alexander 1998, p. 219). We were unable to find any data relating these potential effects directly to impacts on sage-grouse population parameters.

In a study on the Pinedale Anticline in Wyoming, sage-grouse hens that bred on leks within 3 km (1.9 mi) of roads associated with oil and gas development traveled twice as far to nest as did hens bred on leks greater than 3 km (1.9 mi) from roads. Nest initiation rates for hens bred on leks close to roads also were lower (65 versus 89 percent) affecting population recruitment (33 versus 44 percent) (Lyon 2000, p. 33; Lyon and Anderson 2003, pp. 489-490). Lyon and Anderson (2003, p. 490) suggested that roads may be the primary impact of oil and gas development to sage-grouse, due to their persistence and continued use even after drilling and production have ceased. Braun *et al.* (2002, p. 5) suggested that daily vehicular traffic along road networks for oil wells can impact sage-grouse breeding activities based on lek abandonment patterns.

In a study of 804 leks within 100 km (62.5 mi) of Interstate 80 in southern Wyoming and northeastern Utah, Connelly *et al.* (2004, p. 13-12) found that there were no leks within 2 km (1.25 mi) of the interstate and only 9 leks were found between 2 and 4 km (1.25 and 2.5 mi) along this same highway. The number of active leks increased with increasing distance from the interstate. Lek persistence and activity relative to distance from the interstate also were measured. The distance of a lek from the interstate was a significant predictor of lek activity, with leks further from the interstate more likely to be active. An analysis of long-term changes in populations between 1970 and 2003 showed that leks closest (within 7.5 km (4.7 mi)) to the interstate declined at a greater rate than those further away (Connelly *et al.* 2004, p. 13-13). Extirpated sage-grouse range was 60 percent closer to highways (Wisdom *et al.* in press, p. 18). What is not clear from these studies is what specific factor relative to roads (e.g., noise, changes in vegetation, etc.) sage-grouse are responding to. Connelly *et al.* (2004, p. 13-13) caution that they have not included other potential sources of indirect disturbance (e.g., powerlines) in their analyses.

Aldridge *et al.* (2008, p. 992) did not find road density to be an important factor affecting sage-grouse persistence or rangewide patterns in sage-grouse extirpation. However, the authors did not consider the intensity of human use of roads in their modeling efforts. They

also indicated that their analyses may have been influenced by inaccuracies in spatial road data sets, particularly for secondary roads (Aldridge *et al.* 2008, p. 992). However, Wisdom *et al.* (in press, p. 18) found that extirpated range has a 25 percent higher density of roads than occupied range. Wisdom *et al.*'s (in press) rangewide analysis supports the findings of numerous local studies showing that roads can have both direct and indirect impacts on sage-grouse distribution and individual fitness (e.g., Lyon and Anderson 2003, Aldridge and Boyce 2007).

Railroads

Railroads presumably have the same potential impacts to sage-grouse as do roads because they create linear corridors within sagebrush habitats. Railways and the cattle they transport were primarily responsible for the initial spread of *Bromus tectorum* in the intermountain region (Connelly *et al.* 2004, p. 7-25). *B. tectorum*, an exotic species that is unsuitable as sage-grouse habitat, readily invaded the disturbed soils adjacent to railroads. Fires created by trains facilitated the spread of *B. tectorum* into adjacent areas. Knick *et al.* (in press, p. 109) found that railroads cover 487 km^2 (188 mi^2) or less than 0.1 percent of the SGCA, but they estimated railroads could influence 10 percent of the SGCA based adding a 3-km (1.9-mi) buffer to estimate potential impacts from the exotic plants they can spread. Avian collisions with trains occur, although no estimates of mortality rates are documented in the literature (Erickson *et al.* 2001, p. 8).

Summary: Habitat Conversion for Agriculture; Urbanization; Infrastructure

Large losses of sagebrush shrub-steppe habitats due to agricultural conversion have occurred range wide, but have been especially significant in the Columbia Basin of Washington (MZ VI), the Snake River Plain of Idaho (MZ IV), and the Great Plains (MZ I). Conversion of sage brush habitats to cropland continues to occur, although quantitative data is available only for Montana. We do not know the current rate of conversion, but most areas suitable for agricultural production were converted many years ago. The current rate of conversion is likely to increase in the future if incentives for crop production for use as biofuels continue to be offered. Urban and exurban development also have direct and indirect negative effects on sage-grouse, including direct and indirect habitat losses, disturbance, and introduction of new predators and invasive plant species. Given current trends in the Rocky Mountain west, we expect urban and exurban development to continue. Infrastructure such as powerlines, roads, communication towers, and fences continue to fragment sage-grouse habitat. Past and current trends lead us to believe this source of fragmentation will increase into the future. Fragmentation of sagebrush habitats through a variety of mechanisms including those listed above has been cited as a primary cause of the decline of sage-grouse populations (Patterson 1952, pp. 192-193; Connelly and Braun 1997, p. 4; Braun 1998, p. 140; Johnson and Braun 1999, p. 78; Connelly *et al.* 2000a, p. 975; Miller and Eddleman 2000, p. 1; Schroeder and Baydack 2001, p. 29; Johnsgard 2002, p. 108; Aldridge and Brigham 2003, p. 25; Beck *et al.* 2003, p. 203; Pedersen *et al.* 2003, pp. 23-24; Connelly *et al.* 2004, p. 4-15; Schroeder *et al.* 2004, p. 368; Leu *et al.* in press, p. 19). The negative effects of habitat fragmentation on sage-grouse are diverse and include reduced lek persistence, lek attendance, winter habitat use, recruitment, yearling annual survival, and female nest site choice (Holloran 2005, p. 49; Aldridge and Boyce 2007, pp. 517-523; Walker *et al.* 2007a, pp. 2651-2652; Doherty *et al.* 2008, p. 194). Since fragmentation is associated with most anthropogenic activities, the effects are ubiquitous across the species range (Knick *et al.* in press, p. 24). We agree with the assessment that habitat fragmentation is a primary cause of sage-grouse decline and in some areas has already led to population extirpation. We also conclude that habitat fragmentation will continue into the foreseeable future and will continue to threaten the persistence of greater sage-grouse.

Fire

Many of the native vegetative species of the sagebrush-steppe ecosystem are killed by wildfires, and recovery requires many years. As a result of this loss of habitat, fire has been identified as a primary factor associated with greater sage-grouse population declines (Hulet 1983, *in* Connelly *et al.* 2000a, p. 973; Crowley and Connelly 1996, *in* Connelly *et al.* 2000c, p. 94; Connelly and Braun 1997, p. 232; Connelly *et al.* 2000a, p. 973; Connelly *et al.* 2000c, p. 93; Miller and Eddlemen 2000, p. 24; Johnson *et al.*, in press, p. 12; Knick and Hanser, in press, pp. 29-30). In nesting and wintering sites, fire causes direct loss of habitat due to reduced cover and forage (Call and Maser 1985, p. 17). For example, prescribed fires in mountain big sagebrush at Hart Mountain National Antelope Refuge caused a short-term increase in certain forbs, but reduced sagebrush cover, making habitat less suitable for nesting (Rowland and Wisdom 2002, p. 28). Similarly, Nelle *et al.* (2000, p. 586) and Beck *et al.* (2009, p. 400) reported nesting habitat loss from fire, creating a long-term negative impact that will require 25 to 150 years of sagebrush regrowth before sufficient canopy cover becomes available for nesting birds.

In southeastern Idaho, sage-grouse populations were generally declining across the entire study area, but declines were more severe in post-fire years (Connelly *et al.* 2000c, p. 93). Further, Fischer *et al.* (1997, p. 89) concluded that habitat fragmentation caused by fire may influence distribution or migratory patterns in sage-grouse. Hulet (1983, in Connelly *et al.* 2000a, p. 973) documented the loss of leks from fire.

Fire within 54 km (33.6 mi) of a lek is one of two primary factors in predicting lek extirpation (Knick and Hanser in press, p. 26). Small increases in the amount of burned habitat surrounding a lek had a large influence on the probability of lek abandonment (Knick and Hanser, in press, pp. 29-30). Additionally, fire had a negative effect on lek trends in the Snake River Plain (MZ IV) and Southern Great Basin (MZ III) (Johnson *et al.* in press, p.12). Several recent studies have demonstrated that sagebrush area is one of the best landscape predictors of greater sage-grouse persistence (Aldridge *et al.* 2008, p. 987; Doherty *et al.* 2008, p. 191; Wisdom *et al.*, in press, p. 17). While there may be limited instances where burned habitat is beneficial, these gains are lost if sagebrush habitat is not readily available (Woodward 2006, p. 65).

Herbaceous understory vegetation plays a critical role throughout the breeding season as a source of forage and cover for sage-grouse females and chicks. The response of herbaceous understory vegetation to fire varies with differences in species composition, pre-burn site condition, fire intensity, and pre- and post-fire patterns of precipitation. In general, when not considering the synergistic effects of invasive species, any short-term flush of understory grasses and forbs is lost after only a few years and little difference is apparent between burned and unburned sites (Cook *et al.* 1994, p. 298; Fischer *et al.* 1996, p. 196; Crawford 1999, p. 7; Wrobleski 1999, p. 31; Nelle *et al.* 2000, p. 588; Paysen *et al.* 2000, p. 154; Wambolt *et al.* 2001, p. 250). Independent of the response of perennial grasses and forbs to fire, the most important and widespread sagebrush species for greater sage-grouse (i.e., big sagebrush) are killed by fire and

require decades to recover. Prior to recovery, these sites are of limited to no use to sage-grouse (Fischer *et al.* 1996, p. 196; Connelly *et al.* 2000c, p. 90; Nelle *et al.* 2000, p. 588; Beck *et al.* 2009, p. 400). Therefore, fire results in direct, long-term habitat loss.

In addition to altering plant community structure, fires can influence invertebrate food sources (Schroeder *et al.* 1999, p. 5). Ants (Hymenoptera), grasshoppers (Orthoptera), and beetles (Coleoptera) are an essential component of juvenile greater sage-grouse diets, especially in the first 3 weeks of life (Johnson and Boyce 1991, p. 90). Crawford and Davis (2002, p. 56) reported that the abundance of arthropods did not decline following wildfire. Pyle (1992, p. 14) reported no apparent effect of prescribed burning to beetles. However, Fischer *et al.* (1996, p. 197) found that the abundance of insects was significantly lower 2–3 years post-burn. Additionally, grasshopper abundance declined 60 percent in burned plots versus unburned plots 1 year post-burn, but this difference disappeared the second year (Bock and Bock 1991, p. 165). Conversely, Nelle *et al.* (2000, p. 589) reported the abundance of beetles and ants was significantly greater in 1–year-old burns, but returned to pre-burn levels by years 3 to 5. The effect of fire on insect populations likely varies due to a host of environmental factors. Because few studies have been conducted and the results of those available vary, the specific magnitude and duration of the effects of fire on insect communities is still uncertain, as is the effect any changes may have on greater sage-grouse populations.

The few studies that have suggested fire may be beneficial for greater sage-grouse were primarily conducted in mesic areas used for brood-rearing (Klebenow 1970, p. 399; Pyle and Crawford 1996, p. 323; Gates 1983, *in* Connelly *et al.* 2000c, p. 90; Sime 1991, *in* Connelly *et al.* 2000a, p. 972). In this habitat, small fires may maintain a suitable habitat mosaic by reducing shrub encroachment and encouraging understory growth. However, without available nearby sagebrush cover, the utility of these sites is questionable. For example, Slater (2003, p. 63) reported that sage-grouse using burned areas were rarely found more than 60 m (200 ft) from the edge of the burn and may preferentially use the burned and unburned edge habitat. However, Byrne (2002, p. 27) reported avoidance of burned habitat by nesting, brood-rearing, and broodless females. Both Connelly *et al.* (2000c, p. 90) and Fischer *et al.* (1996, p. 196) found that prescribed burns did not improve brood-rearing habitat in Wyoming big sagebrush, as forbs did not increase and insect populations declined. Hence, fires in these locations may negatively affect brood-rearing habitat rather than improve it (Connelly and Braun 1997, p. 11).

The nature of historical fire patterns in sagebrush communities, particularly in *Artemisia tridentata* var. *wyomingensis*, is not well understood and a high degree of variability likely occurred (Miller and Eddleman 2000, p. 16; Zouhar *et al.* 2008, p. 154; Baker in press, p. 16). However, as inferred by several lines of reasoning, fire in sagebrush systems was historically infrequent (Baker in press, pp. 15-16). This conclusion is evidenced by the fact that most sagebrush species have not developed evolutionary adaptations such as re-sprouting and heat-stimulated seed germination found in other shrub-dominated systems, like chaparral, exposed to relatively frequent fire events. Baker (in press, p. 17) suggests natural fire regimes and landscapes were typically shaped by a few infrequent large fire events that occurred at intervals approaching the historical fire rotation (50 to 350 years – see discussion below). The researcher concludes that the historical sagebrush systems likely consisted of extensive sagebrush habitat dotted by small areas of grassland and that this condition was maintained by long interludes of numerous small fires, accounting for little burned area, punctuated by large fire events that consumed large expanses. In general, fire extensively reduces sagebrush within burned areas, and big sagebrush varieties, the most widespread species of sagebrush, can take up to 150 years to reestablish an area (Braun 1998, p. 147; Cooper *et al.* 2007, p. 13; Lesica *et al.* 2007, p. 264; Baker, in press, pp. 15-16).

Fire rotation, or the average amount of time it takes to burn once through a particular landscape, is difficult to quantify in large sagebrush expanses. Because sagebrush is killed by fire, it does not record evidence of prior burns (i.e., fire scars) as do forested systems. As a result, a clear picture of the complex spatial and temporal pattern of historical fire regimes in most sagebrush communities is not available. Widely variable estimates of historical fire rotation have been described in the literature. Depending on the species of sagebrush and other site-specific characteristics, fire return intervals from 10 to well over 300 years have been reported (McArthur 1994, p. 347; Peters and Bunting 1994, p. 33; Miller and Rose 1999, p. 556; Kilpatrick 2000, p. 1; Frost 1998, *in* Connelly *et al.* 2004, p. 7-4; Zouhar *et al.* 2008, p. 154; Baker in press, pp. 15-16). In general, mean fire return intervals in low-lying, xeric, big sagebrush communities range from over 100 to 350 years, and return intervals decrease from 50 to over 200 years in more mesic areas, at higher elevations, during wetter climatic periods, and in locations associated with grasslands (Baker 2006, p. 181; Mensing *et al.* 2006, p. 75; Baker, in press, pp. 15-16; Miller *et al.*, in press, p. 35).

The invasion of exotic annual grasses, such as *Bromus tectorum* and *Taeniatherum asperum* (medusahead), has been shown to increase fire frequency within the sagebrush ecosystem (Zouhar *et al.* 2008, p. 41; Miller *et al.* in press, p. 39). *B. tectorum* readily invades sagebrush communities, especially disturbed sites, and changes historical fire patterns by providing an abundant and easily ignitable fuel source that facilitates fire spread. While sagebrush is killed by fire and is slow to reestablish, *B. tectorum* recovers within 1 to 2 years of a fire event (Young and Evans 1978, p. 285). This annual recovery leads to a readily burnable fuel source and ultimately a reoccurring fire cycle that prevents sagebrush reestablishment (Eiswerth *et al.* 2009, p. 1324). In the Snake River Plain (MZ IV), for example, Whisenant (1990, p. 4) suggests fire rotation due to *B. tectorum* establishment is now as low as 3–5 years. It is difficult and usually ineffective to restore an area to sagebrush after annual grasses become established (Paysen *et al.* 2000, p. 154; Connelly *et al.* 2004, pp. 7-44 to 7-50; Pyke, in press, p. 25). Habitat loss from fire and the subsequent invasion by nonnative annual grasses have negatively affected sage-grouse populations in some locations (Connelly *et al.* 2000c, p. 93).

Evidence exists of a significant relationship between an increase in fire occurrence caused by *Bromus tectorum* invasion in the Snake River Plain and Northern Great Basin since the 1960s (Miller *et al.*, in press, p. 39) and in northern Nevada and eastern Oregon since 1980 (MZs IV and V). The extensive distribution and highly invasive nature of *B. tectorum* poses substantial increased risk of fire and permanent loss of sagebrush habitat, as areas disturbed by fire are highly susceptible to further invasion and ultimately habitat conversion to an altered community state. For example, Link *et al.* (2006, p. 116) show that risk of fire increases from approximately 46 to 100 percent when ground cover of *B. tectorum* increases from 12 to 45 percent or more. In the Great Basin

Ecoregion (defined as east-central California, most of Nevada, and western Utah, MZs IV and V), approximately 58 percent of sagebrush habitats are at moderate to high risk of *B. tectorum* invasion during the next 30 years (Suring *et al.* 2005, p. 138). The BLM estimated that approximately 11.9 million ha (29 million ac) of public lands in the western distribution of the greater sage-grouse (Washington, Oregon, Idaho, Nevada, Utah) were infested with weeds as of 2000 (BLM 2007a, p. 3-28). The most dominant invasive plants consist of grasses in the *Bromus* genus, which represent nearly 70 percent of the total infested area (BLM 2007a, p. 3-28).

Conifer woodlands have expanded into sagebrush ecosystems over the last century (Miller *et al.* in press, p. 34). Woodlands can encroach into sagebrush communities when the interval between fires becomes long enough for seedlings to establish and trees to mature and dominate a site (Miller *et al.* in press, p. 36). However, historical fire rotation appears to have been sufficiently long to allow woodland invasion, and yet extensive stands of mature sagebrush were evident during settlement times (Vale 1975, p. 33; Baker, in press, pp. 15-16). This suggests that causes other than active fire suppression must largely explain recent tree invasions into sagebrush habitats (Baker in press, p. 21, 24). Baker (in press, p. 24) and Miller *et al.* (in press, p. 37) offer a suite of causes, acting in concert with fire exclusion that may better explain the dramatic expansion of conifer woodlands over the last century. These causes include alterations due to domestic livestock grazing (such as reduced competition from native grasses and forbs and facilitation of tree regeneration by increased shrub cover and enhanced seed dispersal), climatic fluctuations favorable to tree regeneration, enhanced tree growth due to increased water use efficiency associated with carbon dioxide fertilization, and recovery from past disturbance (both natural and anthropogenic). Regardless of the cause of conifer woodland encroachment, the rate of expansion is increasing and is resulting in the loss and fragmentation of sagebrush habitats (see discussion in Pinyon-juniper section below).

Between 1980 and 2007, the number of fires and total area burned increased in all MZs across the greater sage-grouse's range except the Snake River Plain (MZ IV) (Miller *et al.*, in press, p. 39). Additionally, average fire size increased in the Southern Great Basin (MZ III) during this same period. However, predicting the amount of habitat that will burn during an ''average fire'' year is difficult due to the highly variable nature of fire seasons. For example, the approximate area burned on or adjacent to BLM-managed lands varied from 140,000 ha (346,000 ac) in 1998 to a 6-fold increase in 1999 (814,200 ha; 2 million ac) returning back down to approximately the 1998 level in 2002 (157,700 ha; 384,743 ac) before rising again 10-fold in 2006 (1.4 million ha; 3.5 million ac) (Miller *et al.*, in press, pp. 39-40).

From 1980 to 2007, wildfires have burned approximately 8.7 million ha (21.5 million ac) of sagebrush, or approximately 18 percent of the estimated 47.5 million ha (117.4 million ac) of sagebrush habitat occurring within the delineated MZs (Baker, in press, p. 43). Additionally, the trend in total acreage burned since 1980 has primarily increased (Miller *et al.*, in press, p. 39). Although fire alters sagebrush habitats throughout the greater sage-grouse's range, fire disproportionately affects the Great Basin (Baker *et al.* in press, p. 20) (i.e., Utah, Nevada, Idaho, and eastern Oregon; MZ III, IV, and V) and will likely influence the persistence of greater sage-grouse populations in the area. In these three MZs combined, nearly 27 percent of sagebrush habitat has burned since 1980 (Baker, in press, p. 43). A primary reason for this disproportionate influence in this region is due to the presence of burned sites and their subsequent susceptibility to invasion by exotic annual grasses.

According to one review, range fires destroyed 30 to 40 percent of sage-grouse habitat in southern Idaho (MZ IV) in a 5–year period (1997–2001) (Signe Sather-Blair, BLM, *in* Healy 2001). This amount included about 202,000 ha (500,000 ac), which burned between 1999 and 2001, significantly altering the largest remaining contiguous patch of sagebrush in the State (Signe Sather-Blair, BLM, *in* Healy 2001). Between 2003 and 2007, Idaho lost an additional 267,000 ha (660,000 ac) of sage-grouse habitat, or approximately 7 percent of the total estimated remaining habitat in the State. Over nine fire seasons in Nevada (1999–2007), about 1 million ha (2.5 million ac) of sagebrush were burned, representing approximately 12 percent of the State's extant sagebrush habitat (Espinosa and Phenix 2008, p. 3). Most of these fires occurred in northeast Nevada (MZ IV) within quality habitat that has traditionally supported high densities of sage-grouse, which also is highly susceptible to *Bromus tectorum* invasion.

Baker (in press, p. 20) calculated recent fire rotation by MZ and compared these to estimates of historical fire rotations. Based on this analysis, the researcher suggests that increased fire rotations since 1980 are presumably outside the historic range of variability and far shorter in floristic regions where Wyoming big sagebrush is common (Baker in press, p. 20). This analysis included MZs III, IV, V, and VI, all of which have extensive *Bromus tectorum* invasions.

In addition to wildfire, land managers are using prescribed fire as well as mechanical and chemical treatments to obtain desired management objectives for a variety of wildlife species and domestic ungulates in sagebrush habitats throughout the range of the greater sage-grouse. While the efficacy of treatments in sagebrush habitats to enhance sage-grouse populations is questionable (Peterson 1970, p. 154; Swensen *et al.* 1987, p. 128; Connelly *et al.* 2000c, p. 94; Nelle *et al.* 2000, p. 590; WAFWA 2009, p. 12; Connelly *et al.* in press c, p. 8), as with wildland fire, an immediate and potentially long-term result is the loss of habitat (Beck *et al.* 2009, p. 400).

Knick *et al.* (in press, p. 33) report that more than 370,000 ha (914,000 ac) of public lands were treated with prescribed fire to address management objectives for many different species between 1997 and 2006, mostly in Oregon and Idaho, and an additional 124,200 ha (306,900 ac) were treated with mechanical means over this same time period, primarily in Utah and Nevada. However, these acreages represent all habitat types and thus overestimate negative impacts to greater sage-grouse. Quantifying the amount of sagebrush-specific habitat treatments is difficult due to the fact that centralized reporting is not typically categorized by habitat. However, agencies under the Department of the Interior (DOI) report species of special interest, including greater sage-grouse, which may occur in proximity to a prescribed treatment. Between 2003 and 2008, approximately 133,500 ha (330,000 ac) of greater sage-grouse habitat have been burned by land managers within the DOI or approximately 22,000 ha (55,000 ac) annually. This acreage does not reflect lands burned by agencies under the USDA (e.g., USFS). Although much of the land under USFS jurisdiction lies outside greater sage-grouse range, this agency manages approximately 8 percent of sagebrush habitats. Ultimately, the amount of sagebrush habitat treated by land managers appears to represent a relatively minor loss when compared to loss incurred by

wildfire. However, in light of the significant habitat loss due to wildfire, and the preponderance of evidence that suggests these treatments are not beneficial to sage-grouse, the rationale for using such treatments to improve sage-grouse habitat deserves further scrutiny.

Sagebrush recovery rates are highly variable, and precise estimates are often hampered by limited data from older burns. Factors contributing to the rate of shrub recovery include the amount of and distance from unburned habitat, abundance and viability of seed in soil seed bank (depending on species, sagebrush seeds are typically viable for one to three seasons), rate of seed dispersal, and pre- and post-fire weather, which influences seedling germination and establishment (Young and Evans 1989, p. 204; Maier *et al.* 2001, p. 701; Ziegenhagen and Miller 2009, p. 201). Based on a review of existing literature, Baker (in press, pp. 14-15) reports that full recovery to pre-burn conditions in *Artemisia tridentata* ssp. *vaseyana* communities ranges between 25 and 100 years and in *A. t.* ssp. *wyomingensis* communities between 50 and 120 years. However, the researcher cautions that data pertaining to the latter community is sparse. What is known is that by 25 years post-fire, *A. t.* ssp. *wyomingensis* typically has less than 5 percent pre-fire canopy cover (Baker in press, p. 15).

A variety of techniques have been employed to restore sagebrush communities following a fire event (Cadwell *et al.* 1996, p. 143; Quinney *et al.* 1996, p. 157; Livingston 1998, p. 41). The extent and efficacy of restoration efforts is variable and complicated by limitations in capacity (personnel, equipment, funding, seed availability, and limited seeding window), incomplete knowledge of appropriate methods, invasive plant species, and abiotic factors, such as weather, that are largely outside the control of land managers (Hemstrom *et al.* 2002, pp. 1250-1251; Pyke, in press, p. 29). While post-fire rehabilitation efforts have benefited from additional resources in recent years, resulting in an increase of treated acres from 28,100 ha (69,436 ac) in 1997 to 1.6 million ha (3.9 million ac) in 2002 (Connelly *et al.* 2004, p. 7-35), acreage treated annually remains far outpaced by acreage disturbed. For example, of the more than 1 million ha (2.5 million ac) of sage-grouse habitat burned during the 2006 and 2007 fire seasons on BLM-managed lands, about 40 percent or 384,000 ha (950,000 ac) had some form of active post-fire restoration such as reseeding. More specifically, Eiswerth *et al.* (2009, p. 1321) report that over the past 20 years within the BLM's Winnemucca District in Nevada, approximately 12 percent of burned areas have been actively reseeded.

The main purpose of the Burned Area Emergency Stabilization and Rehabilitation program (BLM 2007b, pp. 1-2), designed to rehabilitate areas following fire, is to stabilize soils and maintain site productivity rather than to regain site suitability for wildlife (Pyke, in press, p. 24). Consequently, in areas that experience active post-fire restoration efforts, an emphasis is often placed on introduced grasses that establish quickly. Only recently has a modest increase in the use of native species for burned area rehabilitation been reported (Richards *et al.* 1998, p. 630; Pyke, in press, p. 24). Further complicating our understanding of the effectiveness of these treatments is that most managers do not keep track of monitoring data in a routine or systematic fashion (GAO 2003, p. 5). Assuming complete success of restoration efforts on targeted areas, however unlikely, the return of a shrub-dominated community will still require several decades, and landscape restoration may require centuries or longer (Knick 1999, p. 55; Hemstrom *et al.* 2002, p. 1252). Even longer periods may be required for greater sage-grouse to use recovered or restored landscapes (Knick *et al.*, in press, p. 65).

The loss of habitat due to wildland fire is anticipated to increase due to the intensifying synergistic interactions among fire, people, invasive species, and climate change (Miller *et al.*, in press, p. 50). The recent past- and present-day fire regimes across the greater sage-grouse distribution have changed with a demonstrated increase in the more arid Wyoming big sagebrush communities and a decrease across many mountain big sagebrush communities. Both scenarios of altered fire regimes have caused significant losses to greater sage-grouse habitat through facilitating conifer expansion at high-elevation interfaces and exotic weed encroachment at lower elevations (Miller *et al.*, in press, p. 47). In the face of climate change, both of these scenarios are anticipated to worsen (Baker, in press, p. 24; Miller *et al.*, in press, p. 48). Predicted changes in temperature, precipitation, and carbon dioxide are all anticipated to influence vegetation dynamics and alter fire patterns resulting in the increasing loss and conversion of sagebrush habitats (Neilson *et al.* 2005, p. 157). Further, many climate scientists suggest that in addition to the predicted change in climate toward a warmer and generally wetter Great Basin, variability of interannual and interdecadal wet-dry cycles will increase and likely act in concert with fire, disease, and invasive species to further stress the sagebrush ecosystem (Neilson *et al.* 2005, p. 152). The anticipated increase in suitable conditions for wildland fire will likely further interact with people and infrastructure. Human-caused fires have reportedly increased and been shown to be correlated with road presence (Miller *et al.*, in press. p. 40). Given the popularity of off-highway vehicles (OHV) and the ready access to lands in the Great Basin, the increasing trend in both fire ignitions by people and loss of habitat will likely continue.

While multiple factors can influence sagebrush persistence, fire is the primary cause of recent large-scale losses of habitat within the Great Basin, and this stressor is anticipated to intensify. In addition to loss of habitat and its influence on greater sage-grouse population persistence, fragmentation and isolation of populations presents a higher probability of extirpation in disjunct areas (Knick and Hanser, in press, p. 20; Wisdom *et al.*, in press, p. 22). Knick and Hanser (in press, p. 31) suggest extinction is currently more probable than colonization for many great sage-grouse populations because of their low abundance and isolation coupled with fire and human influence. As areas become isolated through disturbances such as fire, populations are exposed to additional stressors and persistence may be hampered by the limited ability of individuals to disperse into areas that are otherwise not self-sustaining. Thus, while direct loss of habitat due to fire has been shown to be a significant factor associated with population persistence, the indirect effect posed by loss of connectivity among populations may greatly expand the influence of this threat beyond the physical fire perimeter.

Summary: Fire

Fire is one of the primary factors linked to population declines of greater sage-grouse because of long-term loss of sagebrush and conversion to monocultures of exotic grasses (Connelly and Braun 1997, p. 7; Johnson *et al.*, in press, p. 12; Knick and Hanser, in press, pp. 29-30). Loss of sagebrush habitat to wildfire has been increasing in western areas of the greater sage-grouse range for the past three decades. The change in fire frequency has been strongly influenced by the presence of exotic annual grasses and significantly deviates from extrapolated historical regimes. Restoration of these communities is challenging, requires

many years, and may, in fact, never be achieved in the presence of invasive grass species. Greater sage-grouse are slow to recolonize burned areas even if structural features of the shrub community may have recovered (Knick *et al.*, in press, p. 46). While it is not currently possible to predict the extent or location of future fire events, the best scientific and commercial information available indicates that fire frequency is likely to increase in the foreseeable future due to increases in cover of *Bromus tectorum* and the projected effects of climate change (see Invasive plants (annual grasses and other noxious weeds), below, and also Climate Change, below).

An analysis of previously extirpated sage-grouse habitats has shown that the extent and abundance of sagebrush habitats, proximity to burned habitat, and degree of connectivity among sage-grouse groups strongly affects persistence (Aldridge *et al.* 2008, p. 987; Knick and Hanser, in press, pp. 29-30; Wisdom *et al.*, in press, p. 17). The loss of habitat caused by fire and the functional barrier burned habitat can pose to movement and dispersal compounds the influence this stressor can have on populations and population dynamics. Barring alterations to the current fire pattern, as well as the difficulties associated with restoration, the concerns presented by this threat will continue and likely strongly influence persistence of the greater sage-grouse, especially in the western half of its range within the foreseeable future.

Invasive Plants (Annual Grasses and Other Noxious Weeds)

For the purposes of our analysis in this section, we consider invasive plants (invasives) to be any nonnative plant that negatively impacts sage-grouse habitat, including annual grasses and other noxious weeds. However, in the literature that we reviewed, the terms noxious weeds and invasives were not consistently defined or applied. Consequently, both terms are used in our discussion to reflect the original use in the sources we cite. In the source material, it was often unclear whether discussions about noxious weeds included invasive annual grasses (e.g., *Bromus tectorum*), referred solely to invasive forbs and invasive perennial grasses, or only referenced species that are listed on State and Federal noxious weed lists (many of which do not consider *B. tectorum* a noxious weed). Nonetheless, all of these can be categorized as nonnative plants that have a negative impact on sage-grouse habitat and thus meet our definition of invasive plants.

Invasives alter plant community structure and composition, productivity, nutrient cycling, and hydrology (Vitousek 1990, p. 7) and may cause declines in native plant populations through competitive exclusion and niche displacement, among other mechanisms (Mooney and Cleland 2001, p. 5446). Invasive plants reduce and, in cases where monocultures occur, eliminate vegetation that sage-grouse use for food and cover. Invasives do not provide quality sage-grouse habitat. Sage-grouse depend on a variety of native forbs and the insects associated with them for chick survival, and sagebrush, which is used exclusively throughout the winter for food and cover. Invasives impact the entire range of sage-grouse, although not all given species are distributed across the entire range. Leu *et al.* (2008, pp. 1119-1139) modeled the risk of invasion by exotic plant species for the entire range of sage-grouse. Areas at high risk for invasion were distributed throughout the range, but were especially concentrated in eastern Washington (MZ VI), southern Idaho (MZ IV), central Utah (MZ III), and northeast Montana (MZ I).

Along with replacing or removing vegetation essential to sage-grouse, invasives fragment existing sage-grouse habitat. They can create long-term changes in ecosystem processes, such as fire-cycles (see discussion under Fire above) and other disturbance regimes that persist even after an invasive plant is removed (Zouhar *et al.* 2008, p. 33). A variety of nonnative annuals and perennials are invasive to sagebrush ecosystems (Connelly *et al.* 2004, pp. 7-107 and 7-108; Zouhar *et al.* 2008, p 144). *Bromus tectorum* is considered most invasive in *Artemisia tridentata* ssp. *wyomingensis* communities, while *Taeniatherum asperum* fills a similar niche in more mesic communities with heavier clay soils (Connelly *et al.* 2004, p. 5-9). Some other problematic rangeland weeds include *Euphorbia esula* (leafy spurge), *Centaurea solstitialis* (yellow starthistle), *Centaurea maculosa* (spotted knapweed), *Centaurea diffusa* (diffuse knapweed), and a number of other *Centaurea* species (DiTomaso 2000, p. 255; Davies and Svejcar 2008, pp. 623-629).

Nonnative annual grasses (e.g., *Bromus tectorum* and *Taeniatherum asperum*) have caused extensive sagebrush habitat loss in the Intermountain West and Great Basin (Connelly *et al.* 2004, pp. 1-2 and 4-16). They impact sagebrush ecosystems by shortening fire intervals to as low as 3 to 5 years, perpetuating their own persistence and intensifying the role of fire (Whisenant 1990, p. 4). Connelly *et al.* (2004, p. 7-5) suggested that fire intervals are shortened to less than 10 years. Although nonnative annual grasses occur throughout the sage-grouse's range, they are more problematic in western States (MZs III, IV, V, and VI) than Rocky Mountain States (MZs I and II) (Connelly *et al.* 2004, p. 5-9).

Quantifying the total amount of sage-grouse habitat impacted by invasives is problematic due to differing sampling methodologies, incomplete sampling, inconsistencies in species sampled, and varying interpretations of what constitutes an infestation (Miller *et al.*, in press, p. 19). Widely variable estimates of the total acreage of weed infestations have been reported. BLM (1996, p. 6) estimated invasives (which may or may not have included *Bromus tectorum* in their estimate) covered at least 3.2 million ha (8 million ac) of BLM lands as of 1994, and predicted 7.7 million ha (19 million ac) would be infested by 2000. However, a qualitative 1991 BLM survey covering 40 million ha (98.8 million ac) of all BLM-managed land in Washington, Oregon, Idaho, Nevada, and Utah (MZs III, IV, V, and VI) reported that introduced annual grasses were a dominant or significant presence on 7 million ha (17.2 million ac) of sagebrush ecosystems (Connelly *et al.* 2004, p. 5-10). An additional 25.1 million ha (62 million ac) had less than 10 percent *B. tectorum* in the understory, but were considered to be at risk of *B. tectorum* invasion (Zouhar 2003, p. 3, in reference to the same survey). More recently, BLM reported that as of 2000, noxious weeds and annual grasses occupied 11.9 million ha (29.4 million ac) of BLM lands in Washington, Oregon, Idaho, Nevada, and Utah (BLM 2007a, p. 3-28). However, when considering all States within the current range of sage-grouse, this number increases to 14.8 million ha (36.5 million ac). Although estimates of the total area infested by *B. tectorum* vary widely, it is clear that *B. tectorum* is a significant presence in western rangelands.

The Landscape Fire and Resource Management Planning Tools Project (LANDFIRE) has a rangewide dataset documenting annual grass distribution. Based on 1999–2002 imagery, at least 885,990 ha (2.2 million ac) of annual grasses occur within the current range of sage-grouse (LANDFIRE 2007). Satellite data only map annual grass monocultures, and not areas where they occur in lower densities or even dominate the sagebrush understory (which is mapped as sagebrush).

Therefore, the LANDFIRE dataset is a gross underestimate of the total acres of infestation. However, this dataset provides a rangewide comparison of annual grass monocultures and identifies the large extent of these monocultures in both the western and eastern part of the sage-grouse's range.

Approximately 80 percent of land in the Great Basin Ecoregion (MZs III, IV, and V) is susceptible to displacement by *Bromus tectorum* (including over 58 percent of sagebrush that is moderately or highly susceptible) within 30 years (Connelly *et al.* 2004, p. 7-17, Suring *et al.* 2005, p. 138). Due to the disproportionate abundance of *B. tectorum* in the Great Basin, suggesting an increased susceptibility to *B. tectorum* invasion than other parts of the sage-grouse's range, Connelly *et al.* (2004, p. 7-8) cautioned that a formal analysis of the risk of *B. tectorum* invasion in other areas was needed before such inferences are made. Also, while nonnative annual grasses are usually associated with lower elevations and drier climates (Connelly *et al.* 2004, p. 5-5), the ecological range of *B. tectorum* continues to expand at low and high elevations (Ramakrishnan *et al.* 2006, pp. 61-62), both southward and eastward (Miller *et al.*, in press, p. 21). Local infestations of *B. tectorum* and other annual grasses occur in Montana, Wyoming, and Colorado (MZs I and II) (Miller *et al.*, in press, p. 21), and there is evidence that *B. tectorum* is impacting fire intervals in Wyoming. For example, 40,469 ha (100,000 ac) of sagebrush that burned in a wildfire southeast of Worland, Wyoming (MZ II), became infested with *B. tectorum*, accelerating the fire interval in this area (Wyoming Big Horn Basin Sage-grouse Local Working Group 2007, pp. 39-40).

Noxious weeds spread about 931 ha (2,300 ac) per day on BLM land and 1,862 ha (4,600 ac) per day on all public land in the West (BLM 1996, p. 1), or increase about 8 to 20 percent annually (*Federal Interagency Committee for the Management of Noxious and Exotic Weeds* 1997, p. v). Invasions are often associated with ground disturbances caused by wildfire, grazing, infrastructure, and other anthropogenic activity (Rice and Mack 1990, p. 84; Gelbard and Belnap 2003, p. 420; Zouhar *et al.* 2008, p. 23), but disturbance is not required for invasives to spread (Young and Allen 1997, p. 531; Roundy *et al.* 2007, p. 614). Invasions also may occur sequentially, where initial invaders (e.g., *Bromus tectorum*) are replaced by new exotics (Crawford *et al.* 2004, p 9; Miller *et al.*, in press, p. 20).

Based on data collected in the western half of the range, Bradley *et al.* (2009, pp. 1511-1521; Bradley 2009, pp. 196-208) predicted favorable conditions for *Bromus tectorum* across much of the sage-grouse's range under current and future (2100) climate conditions. A strong indicator for future *B. tectorum* locations is the proximity to current locations (Bradley and Mustard 2006, p. 1146) as well as summer, annual, and spring precipitation, and winter temperature (Bradley 2009, p. 196). Bradley *et al.* (2009, p. 1517) predicted that in the future some areas will become unfavorable for *B. tectorum* while others will become favorable. Specifically, Bradley *et al.* (2009, p. 1515) predicted that climatically suitable *B. tectorum* habitat will shift northwards, leading to expanded risk in Idaho, Montana, and Wyoming, but reduced risk in southern Nevada and Utah. Despite the potential for future retreat in Nevada and Utah, there will still be climatically suitable *B. tectorum* habitat in these States, well within the range of sage-grouse (see Figure 4b in Bradley *et al.* 2009, p. 1517). Bradley *et al.* (2009, p. 1511) noted that changes in climatic suitability may create restoration opportunities in areas that are currently dominated by invasives. We anticipate that *B. tectorum* will eventually disappear from areas that become climatically unsuitable for this species, but this transition is unlikely to occur suddenly. Also, Bradley *et al.* (2009, p. 1519) cautioned that areas that become unfavorable to *B. tectorum* may become favorable to other invasives, such as *B. rubens* (red brome) in the southern Great Basin, which is more tolerant of higher temperatures. Therefore, areas that become unsuitable for *B. tectorum* will not necessarily be returned to pre-invaded habitat conditions without significant effort. Bradley *et al.* (2009, p. 1519) suggested that modeling and experimental work is needed to assess whether native species could occupy these sites if invasives are reduced or eliminated by climate change.

LANDFIRE also has a rangewide dataset documenting other exotic grasses and forbs, including perennial grasses and annual, perennial, and biennial forbs. Like annual grasses, other invasive plants are grossly underestimated in the LANDFIRE dataset because the dataset only includes monocultures of these species. Based on 1999–2002 imagery, at least 1.3 million ha (3.3 million ac) of other exotic plants occur within the current range of sage-grouse (LANDFIRE 2007). Aside from LANDFIRE, the only other information documenting the specific distribution of invasives within the sage-grouse's range is at a presence–absence scale at the county level. DiTomaso (2000, p. 257) estimated that western rangelands are infested with 2,900,000 ha (7,166,027 ac) of *C. maculosa*, 1,300,000 ha (3,212,357 ac) of *C. diffusa*, 8,000,000 ha (19,768,352 ac) of *C. solstitialis*, and 1,100,000 ha (2,718,148 ac) of *Euphorbia esula,* but this estimate did not describe the distribution of invasives across the landscape. These estimates, combined with estimates of acres infested by *Bromus tectorum,* and the fact that LANDFIRE detected more acres of other noxious weeds than annual grasses, illustrate the severity of the invasives problem.

Invasives that are not annual grasses impact the entire range of sage-grouse, although not all given species are distributed across the entire range. Leu *et al.* (2008, pp. 1119-1139) modeled the risk of invasion by exotic plant species (which also would include annual grasses), for the entire range of sage-grouse. Areas at high risk for invasion were distributed throughout the range, but were especially concentrated in eastern Washington (MZ VI), southern Idaho (MZ IV), central Utah (MZ III), and northeastern Montana (MZ I). Like *Bromus tectorum*, the distribution of other invasives will likely shift with climate change. Bradley *et al.* (2009, p. 1518) predicts that the range of *C. maculosa* will expand in some areas, mainly in parts of Oregon, Idaho, western Wyoming, and Colorado, and will contract in other areas (e.g., eastern Montana). She also predicts that the range of *C. solstitialis* will expand eastward (Bradley *et al.* 2009, p. 1514) and that the invasion risk of *Euphorbia esula* will likely decrease in several States, including parts of Colorado, Oregon, and Idaho (Bradley *et al.* 2009, pp. 1516-1518).

Many efforts are ongoing to restore or rehabilitate sage-grouse habitat affected by invasive species. Common rehabilitation techniques include first reducing the density of invasives using herbicides, defoliation via grazing, pathogenic bacteria and other forms of biocontrol, or prescribed fire (Tu *et al.* 2001; Larson *et al.* 2008, p. 250; Pyke, in press, pp. 25-26). Sites are then typically reseeded with grass and forb mixes, and sometimes planted with sagebrush plugs. Despite ongoing efforts to transform lands dominated by invasive annual grasses into quality sage-grouse habitat, restoration and rehabilitation techniques are considered to be mostly unproven and experimental

(Pyke, in press, pp. 25-28, and see discussion on fire above).

Several components of the restoration process are being investigated with varying success (Pyke, in press, p. 25). Some techniques show promise, such as use of the herbicide Imazapic to control *Bromus tectorum*. However, further analyses of the benefit of this method still need to be conducted (Pyke, in press, p. 27). Also, it will take time for sagebrush to establish and mature in areas currently dominated by annual grasses. Rehabilitation and restoration efforts also are hindered by cost and the ability to procure the equipment and seed needed for projects (Pyke, in press, pp. 29-30). Furthermore, while restoration projects for other species may depend on a single site or landowner, restoration of sage-grouse habitat requires partnerships across multiple ownerships in order to restore and maintain a connective network of intact vegetation (Pyke, in press, pp. 33-34).

Treatment success also depends on factors which are not controllable, such as precipitation received at the treatment site (Pyke, in press, p. 30). For example, only 3.3 to 33.6 percent of recent vegetation treatments conducted by the BLM in annual grassland monocultures were reported as successful (Carlson 2008b, pers. comm.). Areas with established annual grasses that receive less than 22.9 cm (9 in.) of annual precipitation are less likely to benefit from restoration (Connelly *et al.* 2004, p. 7-17, Carlson 2008b, pers. comm.). Consequently, BLM focuses most (98 percent) of their restoration efforts in areas receiving more than 22.9 cm (9 in.) of annual precipitation where there is greater chance of success. Of the BLM treatments in annual grasslands, only 10 percent of acres treated in areas receiving less than 22.9 cm (9 in.) of annual precipitation were considered to be effectively treated. In areas receiving between 22.9 cm (9 in.) and 30.5 cm (12 in.) of annual precipitation, 33.6 percent of the acres were treated effectively, and 3.3 percent of the acres were treated effectively in areas receiving greater than 30.5 cm (12 in.) of annual precipitation (Carlson 2008b, pers. comm.). Since the BLM treatments in annual grassland monocultures included both the reestablishment of native shrub and grass species and greenstripping efforts to reduce the frequency of fires in annual grassland monocultures, it is unclear how many of these successfully treated acres are attributed to restoration versus prevention.

A variety of regulatory mechanisms and nonregulatory measures to control invasive plants exist. However, the extent to which these mechanisms effectively ameliorate the current rate of invasive expansion is unclear. If noxious weeds are spreading at a rate of 931 ha (2,300 ac) per day on BLM lands (BLM 1996, p. 1), this amounts to 339,815 ha (839,500 ac) per year, which includes both suitable and nonsuitable habitat for sage-grouse. It is unclear whether this estimate is limited to noxious weeds or if it includes other invasives (e.g., *Bromus tectorum*). Still, we can compare this estimate to the area of all invasives (excluding conifers) treated by the BLM between October 2005 and September 2007, which totaled 259,897 ha (642,216 ac), i.e., approximately 86,632 ha (214,072 ac) treated annually.

The number of acres treated annually (86,632 ha; 214,072 ac) is not keeping pace with the rate of spread (339,815 ha; 839,500 ac) especially when considering the inability to treat the problem. We acknowledge that the rate of spread on BLM lands also includes areas that are not sage-grouse habitat. However, the rate of spread may not have included *B. tectorum* and only part of the invasive treatments completed by BLM (23.6 percent of treatments in annual grassland monocultures and 7.5 percent of treatments in sagebrush with annual grassland understories) were considered to be effective by the BLM (Carlson 2008b, pers. comm.). Also, treatments are typically considered to be successful based on whether native vegetation was reestablished, maintained, or enhanced, and not based on a positive population response of sage-grouse to the treatment. Therefore, the effectiveness of treatments for sage-grouse is likely much less than reported for vegetation.

The National Invasive Species Council (2008, p. 8) acknowledges that there has been a significant increase in activity and awareness, but that much remains to be done to prevent and mitigate the problems caused by invasive species. As an example, the State of Montana has made much progress through partnerships in reducing noxious weeds in the State from 3.2 million ha (8 million ac) in 2000 to 3.1 million ha (7.6 million ac) in 2008 (Montana Weed Control Association 2008). However, the Montana Noxious Weed Summit Advisory Council Weed Management Task Force (2008, p. III) estimates that to slow weed spread and reduce current infestations by 5 percent annually, they require 2.6 times the current level of funding from a variety of private, local, State, and Federal sources (or $55.8 million versus $21.2 million). In addition to funding, other factors that potentially limit ability to control invasives include the amount of available native seed sources, the time it takes to restore sagebrush to an area once it is removed from a site, and the existence of treatments that are known to be effective in the long-term. Monitoring is limited in many cases and, where it occurs, monitoring typically does not document the population response of sage-grouse to these treatments.

Invasives are a serious rangewide threat, and one of the highest risk factors for sage-grouse based on the plants' ability to out-compete sagebrush, the inability to effectively control them once they become established, and the synergistic interaction between them and other risk factors on the landscape (e.g., wildfire, infrastructure construction). Invasives reduce and eliminate vegetation that is essential for sage-grouse to use as food and cover. Their presence on the landscape has removed and fragmented sage-grouse habitat. Because invasives are widespread, have the ability to spread rapidly, occur near areas susceptible to invasion, and are difficult to control, we anticipate that invasives will continue to replace and reduce the quality of sage-grouse habitat across the range in the foreseeable future. There have been many studies addressing effective invasive control methods, as well as conservation actions to control invasives, with varied success. While some efforts appear successful at smaller scales, prevention (e.g., early detection and fire prevention) appears to be the only known effective tool to preclude or minimize large-scale habitat loss from invasive species in the future.

Pinyon-Juniper Encroachment

Pinyon-juniper woodlands are a native habitat type dominated by pinyon pine (*Pinus edulis*) and various juniper species (*Juniperus* spp.) that can encroach upon, infill, and eventually replace sagebrush habitat. These two woodland types are often referred to collectively as pinyon-juniper; however, some portions of the sage-grouse's range are only impacted by juniper encroachment. Commons *et al.* (1999, p. 238) found that the number of male Gunnison sage-grouse (*C. minimus*) on leks in southwestern Colorado doubled after pinyon-juniper removal and mechanical treatment of mountain sagebrush and deciduous brush. Hence, we infer that some greater sage-grouse populations have been negatively affected by pinyon-juniper encroachment and that some populations will decline in the future due to projected increases in the

pinyon-juniper type, especially in areas where pinyon-juniper encroachment is a large-scale threat (parts of MZs III, IV, and V). Doherty *et al.* (2008, p. 187) reported a strong avoidance of conifers by female greater sage-grouse in the winter, further supporting our previous inference. Also, Freese's (2009, pp. 84-85, 89-90) 2–year telemetry study in central Oregon found that sage-grouse used areas with less than 5 percent juniper cover more often in the breeding and summer seasons than similar habitat that had greater than 5 percent juniper cover. Therefore, pinyon-juniper encroachment into occupied sage-grouse habitat reduces, and likely eventually eliminates, sage-grouse occupancy in these areas.

Pinyon-juniper woodlands are often associated with sagebrush communities and currently occupy at least 18 million ha (44.6 million ac) of the Intermountain West within the sage-grouse's range (Crawford *et al.* 2004, p. 8; Miller *et al.* 2008, p. 1). Pinyon-juniper extent has increased 10-fold in the Intermountain West since European settlement causing the loss of many bunchgrass and sagebrush-bunchgrass communities (Miller and Tausch 2001, pp. 15-16). This expansion has been attributed to the reduced role of fire, the introduction of livestock grazing, increases in global carbon dioxide concentrations, climate change, and natural recovery from past disturbance (Miller and Rose 1999, pp. 555-556; Miller and Tausch 2001, p. 15; Baker, in press, p. 24; see also discussion under Fire above).

Connelly *et al.* (2004, pp. 7-8 to 7-14) estimated that approximately 60 percent of sagebrush in the Great Basin was at low risk of displacement by pinyon-juniper in 30 years, 6 percent at moderate risk, and 35 percent at high risk. Mountain big sagebrush appears to be most at risk of pinyon-juniper displacement (Connelly *et al.* 2004, pp. 7-13). When juniper increases in mountain big sagebrush communities, shrub cover declines and the season of available succulent forbs is shortened due to soil moisture depletion (Crawford *et al.* 2004, p. 8). As with *Bromus tectorum*, the Great Basin appears more susceptible to pinyon-juniper invasion than other areas of the sage-grouse's range; however, Connelly *et al.* (2004, pp. 7-8) cautioned that a formal analysis of the risks posed in other locations was needed before such inferences could be made.

Annual encroachment rates that were reported in five studies ranged from 0.3 to 31 trees per hectare (0.7 to 77 trees per acre) (Sankey and Germino 2008, p. 413). For the three studies that measured the percent increase in juniper cover per year, cover increased between 0.4 and 4.5 percent annually (Sankey and Germino 2008, p. 413). Sankey and Germino (2008, p. 413) compared juniper encroachment rates from previous research to their study. Their estimate that juniper cover increased 0.7 to 1.5 percent annually was based on a 22 to 30 percent increase in cover between 1985 and 2005 at their southeastern Idaho study site (Sankey and Germino 2008, pp. 412-413).

Pinyon-juniper expansion into sagebrush habitats, with subsequent replacement of sagebrush communities, has been well documented (Miller *et al.* 2000, p. 575; Connelly *et al.* 2004, p. 7-5; Crawford *et al.* 2004, p. 2; Miller *et al.* 2008, p. 1). However, few studies have documented woodland dynamics at the landscape level across different ecological provinces, creating some uncertainty regarding the total amount of expansion that has occurred in sagebrush communities (Miller *et al.* 2008, p. 1). Regardless, we know that up to 90 percent of existing woodlands in the sagebrush-steppe and Great Basin sagebrush vegetation types were previously dominated by sagebrush vegetation prior to the late 1800s (Miller *et al.*, in press, pp. 23-24). Based on past trends and the current distribution of pinyon-juniper relative to sagebrush habitat, we anticipate that expansion will continue at varying rates across the landscape and cause further loss of sagebrush habitat within the western part of the sage-grouse's range, especially in parts of MZs III, IV, and V.

While pinyon-juniper expansion appears less problematic in the eastern portion of the range (MZs I, II and VII) and silver sagebrush areas (primarily MZ I), woodland encroachment is a threat mentioned in Wyoming, Montana, and Colorado State sage-grouse conservation plans, indicating that this is of some concern in these States as well (Stiver *et al.* 2006, p. 2-23). Colorado's State plan mapped areas threatened by pinyon-juniper encroachment in northwestern Colorado, and specifically attributed some sage-grouse habitat loss in Colorado to pinyon-juniper expansion (Colorado Greater Sage-grouse Steering Committee 2008, pp. 179, 182). Furthermore, LANDFIRE (2007) data illustrates extensive coverage of pinyon-juniper woodlands in parts of northwestern Colorado within the range of sage-grouse. These data also show limited pinyon-juniper coverage in Montana and Wyoming; however, LANDFIRE data could be a major underestimate of juniper because it is difficult to classify pinyon-juniper woodlands with satellite imagery when the trees occur at low densities (Hagen 2005, p. 142).

Recently, many conservation actions have addressed this threat using a variety of techniques (e.g., mechanical, herbicide, cutting, burning) to remove conifers in sage-grouse habitat. The effectiveness of these treatments varies with the technique used and proximity of the site to invasive plant infestations, among other factors. We are not aware of any study documenting a direct correlation between these treatments and increased greater sage-grouse productivity; however, we infer some level of positive response based on Commons *et al.*'s (1999) Gunnison sage-grouse study and the documented avoidance, or reduced use, by sage-grouse of areas where pinyon-juniper has encroached upon sagebrush communities (Doherty *et al.* 2008, p. 187; Freese 2009, pp. 84-85, 89-90). However, since the effectiveness of treatments for sage-grouse is usually based on a short-term, anecdotal evaluation of whether pinyon-juniper was successfully removed from a site, it is unclear whether pinyon-juniper removal has a positive long-term population-level impact for sage-grouse. In most cases it is still too early to measure a population response to these treatments (Oregon Department of Fish and Wildlife (ODFW) 2008, p. 3). Consequently, we do not know if these efforts are effectively ameliorating the threat of pinyon-juniper expansion at the site-level.

Furthermore, while many acres have been treated since 2004, treatments are not likely keeping pace with the current rate of pinyon-juniper encroachment, at least in parts of the range. For example, while Oregon has treated approximately 8,094 ha (20,000 ac) of juniper to restore native sagebrush habitat between 2003 and early 2008 (about 1,619 ha or 4,000 ac per year; ODFW 2008, p. 3), LANDFIRE data show at least 106,882 ha (264,110 ac) of juniper occur within 4.8 km (3 mi) of Oregon leks. This distance (4.8 km; 3 mi) reflects the upper estimate of a typical pinyon seed dispersal event, although seeds may be dispersed shorter distances and up to at least 10 km (6.2 mi) (Chambers *et al.* 1999, p. 12). At this rate, it would take approximately 60 years to remove the threat of juniper encroachment within 3 miles of sage-grouse leks in Oregon, assuming expansion does not continue.

Again, LANDFIRE data provides a gross underestimate of pinyon-juniper since it misses single, large trees. This underestimate suggests that it will take longer than 60 years to fully address the threat of juniper encroachment in

Oregon, if conservation actions continue to occur at the current rate. Furthermore, not all treatments are effective. Of the 38,780 ha (95,826 ac) treated by BLM in Fiscal Year (FY) 2006 and FY 2007, only 21,598 ha (53,369 ac), or 55.7 percent were considered to be effective by the BLM (Carlson 2008b, pers. comm.). Again, the measure of effectiveness typically refers to whether vegetation was treated successfully, and not whether sage-grouse use an area that has been treated.

Summary: Invasive Plants and Pinyon-Juniper Encroachment

Invasives plants negatively impact sage-grouse primarily by reducing or eliminating native vegetation that sage-grouse require for food and cover, resulting in habitat loss and fragmentation. A variety of nonnative annuals and perennials (e.g., Bromus tectorum, Euphorbia esula) and native conifers (e.g., pinyon pine, juniper species) are invasive to sagebrush ecosystems. Nonnative invasives, including annual grasses and other noxious weeds, continue to expand their range, facilitated by ground disturbances such as wildfire, grazing, and infrastructure. Pinyon and juniper and some other native conifers are expanding and infilling their current range mainly due to decreased fire return intervals, livestock grazing, and increases in global carbon dioxide concentrations associated with climate change, among other factors.

Collectively, invasives plants impact the entire range of sage-grouse, although they are most problematic in the Intermountain West and Great Basin (MZs III, IV, V, and VI). A large portion of the Great Basin is at risk of *B. tectorum* invasion or pinyon-juniper encroachment within the next 30 years. Approximately 80 percent of land in the Great Basin Ecoregion (MZs III, IV, and V) is susceptible to displacement by *B. tectorum* within 30 years (Connelly *et al.* 2004, p. 7-17, Suring *et al.* 2005, p. 138). Connelly *et al.* (2004, pp. 7-8 to 7-14) estimated that approximately 35 percent of sagebrush in the Great Basin was at high risk of displacement by pinyon-juniper in 30 years. *Bromus tectorum* is widespread at lower elevations and pinyon-juniper woodlands tend to expand into higher elevation sagebrush habitats, creating an elevational squeeze from both low and high elevations. Climate change will likely alter the range of individual invasive species, increasing fragmentation and habitat loss of sagebrush communities. Despite the potential shifting of individual species, invasive plants will persist and continue to spread rangewide in the foreseeable future.

A variety of restoration and rehabilitation techniques are used to treat invasive plants, but they can be costly and are mostly unproven and experimental. The success of treatments, particularly for annual grassland restoration, depends on uncontrollable factors (e.g., precipitation). While some efforts appear successful at smaller scales, prevention appears to be the only known effective tool to preclude large-scale habitat loss from invasive annuals and perennials in the future. Pinyon-juniper treatments, particularly when done in the early stages of encroachment when sagebrush and forb understory is still intact, have the potential to provide an immediate benefit to sage-grouse. However, studies have not yet documented a correlation between pinyon-juniper treatments and increased greater sage-grouse productivity.

Grazing

Native herbivores, such as pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), bison (*Bison bison*), and other ungulates were present in low numbers on the sagebrush-steppe region prior to European settlement of western States (Osborne 1953, p. 267; Miller *et al.* 1994, p. 111), and sage-grouse co-evolved with these animals. However, mass extinction of the majority of large herbivores occurred 10,000 to 12,000 years ago (Knick *et al.* 2003, p. 616; Knick *et al.*, in press, p. 40). From that period up until European settlement, many areas of sagebrush-steppe still did not support herds of large ungulates and grazing pressure was likely sporadic and localized (Miller *et al.* 1994, p. 113; Plew and Sundell 2000, p. 132; Grayson 2006, p. 921). Additionally, plants of the sagebrush-steppe lack traits that reflect a history of large ungulate grazing pressure (Mack and Thompson 1982, pp. 757). Therefore, native vegetation communities within the sagebrush ecosystem evolved in the absence of significant grazing presence (Mack and Thompson 1982, p. 768). With European settlement of western States (1860 to the early 1900s), unregulated numbers of cattle, sheep, and horses rapidly increased, peaking at the turn of the century (Oliphant 1968, p. vii; Young *et al.* 1976, pp. 194-195, Carpenter 1981, p. 106; Donahue 1999, p. 15) with an estimated 19.6 million cattle and 25 million sheep in the West (BLM 2009a, p. 1).

Excessive grazing by domestic livestock during the late 1800s and early 1900s, along with severe drought, significantly impacted sagebrush ecosystems (Knick *et al.* 2003, p. 616). Long-term effects from this overgrazing, including changes in plant communities and soils, persist today (Knick *et al.* 2003, p.116). Currently, livestock grazing is the most widespread type of land use across the sagebrush biome (Connelly *et al.* 2004, p. 7-29); almost all sagebrush areas are managed for livestock grazing (Knick *et al.* 2003, p. 616; Knick *et al.*, in press, p. 27).

Although little direct experimental evidence links grazing practices to population levels of greater sage-grouse (Braun 1987, p. 137; Connelly and Braun 1997, p. 231), the impacts of livestock grazing on sage-grouse habitat and on some aspects of the life cycle of the species have been studied. Sage-grouse need significant grass and shrub cover for protection from predators, particularly during nesting season, and females will preferentially choose nesting sites based on these qualities (Hagen *et al.* 2007, p. 46). The reduction of grass heights due to livestock grazing in sage-grouse nesting and brood-rearing areas has been shown to negatively affect nesting success when cover is reduced below the 18 cm (7 in.) needed for predator avoidance (Gregg *et al.* 1994, p. 165). Based on measurements of cattle foraging rates on bunchgrasses both between and under sagebrush canopies, the probability of foraging on under-canopy bunchgrasses depends on sagebrush morphology, and consequently, the effects of grazing on nesting habitats might be site specific (France *et al.* 2008, pp. 392-393).

Several authors have noted that grazing by livestock could reduce the suitability of breeding and brood-rearing habitat, negatively affecting sage-grouse populations (Braun 1987, p. 137; Dobkin 1995, p. 18; Connelly and Braun 1997, p. 231; Beck and Mitchell 2000, pp. 998-1000). Exclosure studies have demonstrated that domestic livestock grazing reduces water infiltration rates and cover of herbaceous plants and litter, as well as compacting soils and increasing soil erosion (Braun 1998, p. 147; Dobkin *et al.* 1998, p. 213). These impacts result in a change in the proportion of shrub, grass, and forb components in the affected area, and an increased invasion of exotic plant species that do not provide suitable habitat for sage-grouse (Mack and Thompson 1982, p. 761; Miller and Eddleman 2000, p. 19; Knick *et al.*, in press, p. 41).

Livestock also may compete directly with sage-grouse for rangeland resources. Cattle are grazers, feeding mostly on grasses, but they will make seasonal use of forbs and shrub species

like sagebrush (Vallentine 1990, p. 226). Domestic sheep are intermediate feeders making high use of forbs, but also using a large volume of grass and shrub species like sagebrush (Vallentine 1990, pp. 240-241). Sheep consume rangeland forbs in occupied sage-grouse habitat (Pederson *et al.* 2003, p. 43) and, in general, forb consumption may reduce food availability for sage-grouse. This impact is particularly important for pre-laying hens, as forbs provide essential calcium, phosphorus, and protein (Barnett and Crawford 1994, p. 117). A hen's nutritional condition affects nest initiation rate, clutch size, and subsequent reproductive success (Barnett and Crawford 1994, p.117; Coggins 1998, p. 30).

Other effects of direct competition between livestock and sage-grouse depend on condition of the habitat and the grazing practices. Thus, the effects vary across the range of the greater sage-grouse. For example, Aldridge and Brigham (2003, p. 30) suggest that poor livestock management in mesic sites, which are considered limited habitats for sage-grouse in Alberta (Aldridge and Brigham 2002, p. 441), results in a reduction of forbs and grasses available to sage-grouse chicks, thereby affecting chick survival.

Other consequences of grazing include several related to livestock trampling of grouse and habitat. Although the effect of trampling at a population level is unknown, outright nest destruction has been documented and the presence of livestock can cause sage-grouse to abandon their nests (Rasmussen and Griner 1938, p. 863; Patterson 1952, p. 111; Call and Maser 1985, p. 17; Holloran and Anderson 2003, p. 309; Coates 2007, p.28). Coates (2007, p. 28) documented nest abandonment following partial nest depredation by a cow. In general all recorded encounters between livestock and grouse nests resulted in hens flushing from nests, which could expose the eggs to predation; there is strong evidence that visual predators like ravens use hen movements to locate sage-grouse nests (Coates 2007, p.33). Livestock also may trample sagebrush seedlings, thereby removing a source of future sage-grouse food and cover (Connelly *et al.* 2004, p. 7-31). Trampling of soil by livestock can reduce or eliminate biological soil crusts making these areas susceptible to *Bromus tectorum* invasion (Mack 1981 as cited in Miller and Eddleman 2000, p. 21; Young and Allen 1997, p. 531).

Some livestock grazing effects may have positive consequences for sage-grouse. Evans (1986, p. 67) found that sage-grouse used grazed meadows significantly more during late summer than ungrazed meadows because grazing had stimulated the regrowth of forbs. Klebenow (1981, p. 121) noted that sage-grouse sought out and used openings in meadows created by cattle grazing in northern Nevada. Also, both sheep and goats have been used to control invasive weeds (Mosley 1996 as cited in Connelly *et al.* 2004, p. 7-49; Merritt *et al.* 2001, p. 4; Olsen and Wallander 2001, p. 30) and woody plant encroachment (Riggs and Urness 1989, p. 358) in sage-grouse habitat.

Sagebrush plant communities are not adapted to domestic grazing disturbance. Grazing changed the functioning of systems into less resilient, and in some cases, altered communities (Knick *et al.*, in press, p. 39). The ability to restore or rehabilitate areas depends on the condition of the area relative to its site potential (Knick *et al.*, in press, p. 39). For example, if an area has a balanced mix of shrubs and native understory vegetation, a change in grazing management can restore the habitat to its potential vigor (Pyke, in press, p. 11). Wambolt and Payne (1986, p. 318) found that rest from grazing had a better perennial grass response than other treatments. Active restoration would be required where native understory vegetation is much reduced (Pyke, in press, p. 15). But, if an area has soil loss and/or invasive species, returning the site to the native historical plant community may be impossible (Daubenmire 1970, p. 82; Knick *et al.*, in press, p. 39; Pyke, in press, p. 17). Aldridge *et al.* (2008, p. 990) did not find any relationship between sage-grouse persistence and livestock densities. However, the authors noted that livestock numbers do not necessarily correlate with range condition. They concluded that the intensity, duration, and distribution of livestock grazing are more influential on rangeland condition than the livestock density values used in their modeling efforts (Aldridge *et al.* 2008, p. 990).

Extensive rangeland treatment has been conducted by federal agencies and private landowners to improve conditions for livestock in the sagebrush-steppe region (Connelly *et al.* 2004, p. 7- 28; Knick *et al.*, in press, p. 28). By the 1970s, over 2 million ha (5 million ac) of sagebrush are estimated to have been mechanically treated, sprayed with herbicide, or burned in an effort to remove sagebrush and increase herbaceous forage and grasses (Crawford *et al.* 2004, p. 12). The BLM treated over 1,800,000 ha (4,447,897 ac) from 1940 to 1994, with 62 percent of the treatment occurring during the 1960s (Miller and Eddleman 2000, p. 20). Braun (1998, p. 146) concluded that, since European settlement of western North America, all sagebrush habitats used by greater sage-grouse have been treated in some way to reduce shrub cover. The use of chemicals to control sagebrush was initiated in the 1940s and intensified in the 1960s and early 1970s (Braun 1987, p. 138). Crawford *et al.* (2004, p. 12) hypothesized that reductions in sage-grouse habitat quality (and possibly sage-grouse numbers) in the 1970s may have been associated with extensive rangeland treatments to increase forage for domestic livestock.

Greater sage-grouse response to herbicide treatments depends on the extent to which forbs and sagebrush are killed. Chemical control of sagebrush has resulted in declines of sage-grouse breeding populations through the loss of live sagebrush cover (Connelly *et al.* 2000a, p. 972). Herbicide treatment also can result in sage-grouse emigration from affected areas (Connelly *et al.* 2000a, p. 973), and has been documented to have a negative effect on nesting, brood carrying capacity (Klebenow 1970, p. 399), and winter shrub cover essential for food and thermal cover (Pyrah 1972 and Higby 1969 as cited in Connelly *et al.* 2000a, p. 973). Conversely, small treatments interspersed with nontreated sagebrush habitats did not affect sage-grouse use, presumably due to minimal effects on food or cover (Braun 1998, p. 147). Also, application of herbicides in early spring to reduce sagebrush cover may enhance some brood-rearing habitats by increasing the coverage of herbaceous plant foods (Autenrieth 1981, p. 65).

Mechanical treatments are designed to either remove the aboveground portion of the sagebrush plant (mowing, roller chopping, and roto-beating), or to uproot the plant from the soil (grubbing, bulldozing, anchor chaining, cabling, railing, raking, and plowing; Connelly *et al.* 2004, p. l7-47). These treatments were begun in the 1930s and continued at relatively low levels to the late 1990s (Braun 1998, p. 147). Mechanical treatments, if carefully designed and executed, can be beneficial to sage-grouse by improving herbaceous cover, forb production, and sagebrush resprouting (Braun 1998, p. 147). However, adverse effects also have been documented (Connelly *et al.* 2000a, p. 973). For example, in Montana, the number of breeding males declined by 73 percent after 16 percent of the 202-km^2 (78- mi^2) study area was plowed (Swenson *et al.* 1987, p. 128). Mechanical treatments in blocks greater than 100 ha (247 ac), or of any size seeded with exotic grasses, degrade sage-grouse habitat by altering the

structure and composition of the vegetative community (Braun 1998, p. 147).

The current extent to which mechanical, chemical, and prescribed fire methods are used to remove or control sagebrush is not known, particularly with regard to private lands. However, BLM has stated that with rare exceptions, they no longer are involved in actions that convert sagebrush to other habitat types, and that mechanical or chemical treatments in sagebrush habitat on BLM lands currently focus on improving the diversity of the native plant community, reducing conifer encroachment, or reducing the risk of a large wildfire (see discussion of Fire above; BLM 2004, p. 15).

Historically, the elimination of sagebrush followed with rangeland seedings was encouraged to improve forage for livestock grazing operations (Blaisdell 1949, p. 519). Large expanses of sagebrush removed via chemical and mechanical methods have been reseeded with nonnative grasses, such as crested wheatgrass (*Agropyron cristatum*), to increase forage production on public lands (Pechanec *et al.* 1965 as cited in Connelly *et al.* 2004, p.7-28). These treatments reduced or eliminated many native grasses and forbs present prior to the seedings (Hull 1974, p. 217). Sage-grouse are affected indirectly through the loss of native forbs that serve as food and loss of native grasses that provide concealment or hiding cover (Connelly *et al.* 2004, p. 4-4).

Water developments for the benefit of livestock and wild ungulates on public lands are common (Connelly *et al.* 2004, p. 7-35). Development of springs and other water sources to support livestock in upland shrub-steppe habitats can artificially concentrate domestic and wild ungulates in important sage-grouse habitats, thereby exacerbating grazing impacts in those areas such as heavy grazing and vegetation trampling (Braun 1998, p. 147; Knick *et al.*, in press, p. 42). Diverting the water sources has the secondary effect of changing the habitat present at the water source before diversion. This impact could result in the loss of either riparian or wet meadow habitat important to sage-grouse as sources of forbs or insects. Water developments for livestock and wild ungulates also could be used as mosquito breeding habitat, and thus have the potential to facilitate the spread of West Nile virus (see discussion under Factor C: Disease and Predation).

Another indirect negative impact to sage-grouse from livestock grazing occurs due to the placement of thousands of miles of fences for livestock management purposes (see discussion above under Infrastructure). Fences cause direct mortality through collision and indirect mortality through the creation of predator perch sites, the potential creation of predator corridors along fences (particularly if a road is maintained next to the fence), incursion of exotic species along the fencing corridor, and habitat fragmentation (Call and Maser 1985, p. 22; Braun 1998, p. 145; Connelly *et al.* 2000a, p. 974; Beck *et al.* 2003, p. 211; Knick *et al.* 2003, p. 612; Connelly *et al.* 2004, p. 1-2).

The impacts of livestock operations on sage-grouse depend upon stocking levels, season of use, and utilization levels. Cattle and sheep Animal Unit Months (AUMs) (the amount of forage required to feed one cow with calf, one horse, five sheep, or five goats for 1 month) on all Federal land have declined since the early 1900s (Laycock *et al.* 1996, p. 3). By the 1940s, AUMs on all Federal lands (not just areas occupied by sage-grouse) were estimated to be 14.6 million, increasing to 16.5 million in the 1950s, and gradually declining to 10.2 million by the 1990s (Miller and Eddleman 2000, p. 19). Although AUMs have decreased over time, we cannot assume that the net impact of grazing has decreased because the productivity of those lands has decreased (Knick *et al.*, in press, p. 42). As of 2007, the number of permitted AUMs for BLM lands in States where sage-grouse occur totaled 7,118,989 (Beever and Aldridge, in press, p. 19-20). We estimate that those permitted AUMs occur in approximately 18,783 BLM grazing allotments in sage-grouse habitat (Stoner 2008). Since 2005, 644 (3.4 percent) of those allotments have decreased the permitted AUMs (Service 2008a). However, BLM tracks the number of AUMs permitted rather than the number of AUMs actually used. The number permitted typically is higher than what is used, thus we do not know how the decrease on paper corresponds to the actual number of AUMs for the last four years.

Wild Horse and Burro Grazing

Free-roaming horses and burros have been a component of sagebrush and other arid communities since they were brought to North America at the end of the 16th century (Wagner 1983, p. 116; Beever 2003, p. 887). About 31,000 wild horses occur in 10 western States (including 2 states outside the range of the greater sage-grouse), with herd sizes being largest in Nevada, Wyoming, and Oregon, which are the States with the most extensive sagebrush cover (Connelly *et al.* 2004, p. 7-37). Of about 5,000 burros occur in five western States approximately 700 occur within the SGCA (Connelly *et al.* 2004, p.7-37). Beever and Aldridge (2009, in press, p. 7) estimate that about 12 percent (78, 389 km^2, 30,266 mi^2) of sage-grouse habitat is managed for free-roaming horses and burros. However, the extent to which the equids use land outside of designated management areas is difficult to quantify but may be considerable.

We are unaware of any studies that directly address the impact of wild horses or burros on sagebrush and sage-grouse. However, some authors have suggested that wild horses could negatively impact important meadow and spring brood-rearing habitats used by sage-grouse (Crawford *et al.* 2004, p. 11; Connelly *et al.* 2004, p. 7-37). Horses are generalists, but seasonally their diets can be almost wholly comprised of grasses (Wagner 1983, pp. 119-120). A comparison of areas with and without horse grazing showed 1.9 to 2.9 times more grass cover and higher grass density in areas without horse grazing (Beever *et al.* 2008 as cited Beever and Aldridge in press, p. 11). Additionally, sites with horse grazing had less shrub cover and more fragmented shrub canopies (Beever and Aldridge in press, p. 12). As noted above, sage-grouse need significant grass and shrub cover for protection from predators particularly during nesting season, and females will preferentially choose nesting sites based on these qualities (Hagen *et al.* 2007, p. 46). Sites with grazing also generally showed less plant diversity, altered soil characteristics, and 1.6 to 2.6 times greater abundance of nonnative *Bromus tectorum* (Beever *et al.* 2008 as cited in Beever and Aldridge 2009, in press, p. 13). These impacts combined indicate that horse grazing has the potential to result in an overall decrease in the quality and quantity of sage-grouse habitat in areas where such grazing occurs.

Currently, free-roaming equids consume an estimated 315,000 to 433,000 AUMs as compared to over 7 million AUMs for domestic livestock within the range of greater sage-grouse (Beever and Aldridge, in press, p. 21). Cattle typically outnumber horses by a large degree in areas where both occur; however, locally ratios of 2:1 (horse:cow) have been reported (Wagner 1983, p.126). The local effects of ungulate grazing depend on a host of abiotic and biotic factors (e.g., elevation, season, soil composition, plant productivity, and composition). Additional significant biological and behavioral differences influence the impact of horses as compared to cattle grazing on habitat (Beever 2003, pp.

888-890). For example, due to physiological differences, a horse must forage longer and consumes 20 to 65 percent more forage than would a cow of equivalent body mass (Wagner 1983, p. 121; Menard *et al.* 2002, p.127). Unlike cattle and other ungulates, horses can crop vegetation close to the ground, potentially limiting or delaying recovery of plants (Menard *et al.* 2002, p.127). In addition, horses seasonally move to higher elevations, spend less time at water, and range farther from water sources than cattle (Beever and Aldridge in press, pp. 20, 21). Given these differences, along with the confounding factor of past range use, it is difficult to assess the overall magnitude of the impact of horses on the landscape in general, or on sage-grouse habitat in particular. In areas grazed by both horses and cattle, whether the impacts are synergistic or additive is currently unknown (Beever and Aldridge, in press, p. 21).

Wild Ungulate Herbivory

Native herbivores, such as elk (*Cervus elaphus*), mule deer, and pronghorn antelope coexist with sage-grouse in sagebrush ecosystems (Miller *et al.* 1994, p. 111). These ungulates are present in sagebrush ecosystems during various seasons based on dietary needs and forage availability (Kufeld 1973, p. 106-107; Kufeld *et al.* 1973 as cited in Wallmo and Regelin 1981, p. 387-396; Allen *et al.* 1984, p. 1). Elk primarily consume grasses but are highly versatile in consumption of forbs and shrubs when grasses are not available (Kufeld 1973, pp. 106-107; Vallentine 1990, p. 235). In the winter, heavy snow forces elk to lower-elevation sagebrush areas where they forage heavily on sagebrush (Wambolt and Sherwood 1999, p. 225). Mule deer utilize forbs, shrubs, and grasses throughout the year dependent upon availability and preference (Kufeld *et al.* 1973 as cited in Wallmo and Regelin 1981, pp. 389-396). Pronghorn antelope, most commonly associated with grasslands and sagebrush, consume a wide variety of available shrubs and forbs and consume new spring grass growth (Allen *et al.* 1984, p. 1; Vallentine 1990, p. 236).

We are unaware of studies evaluating the effects of native ungulate herbivory on sage-grouse and sage-grouse habitat. However, concentrated native ungulate herbivory may impact vegetation in sage-grouse habitat on a localized scale. Native ungulate winter browsing can have substantial, localized impacts on sagebrush vigor, resulting in decreased shrub cover or sagebrush mortality (Wambolt 1996, p. 502; Wambolt and Hoffman 2004, p. 195). Additionally, despite decreased habitat availability, elk and mule deer populations are currently higher than pre-European estimates (Wasley 2004, p. 3; Young and Sparks 1985, pp. 67-68). As a result, some States started small-scale supplemental feeding programs for deer and elk. In those localized areas, vegetation is heavily utilized from the concentration of animals (Doman and Rasmussen 1944, p. 319; Smith 2001, pp. 179-181). Unlike domestic ungulates, wild ungulates are not confined to the same area, at the same time each year. Therefore, the impacts from wild ungulates are spread more diffusely across the landscape, resulting in minimal long-term impacts to the vegetation community.

Summary: Grazing

Livestock management and domestic grazing can seriously degrade sage-grouse habitat. Grazing can adversely impact nesting and brood-rearing habitat by decreasing vegetation concealment from predators. Grazing also has been shown to compact soils, decrease herbaceous abundance, increase erosion, and increase the probability of invasion of exotic plant species. Once plant communities have an invasive annual grass understory dominance, successful restoration or rehabilitation techniques are largely unproven and experimental (Pyke, in press, p. 25). Massive systems of fencing constructed to manage domestic livestock cause direct mortality to sage-grouse in addition to degrading and fragmenting habitats. Livestock management also can involve water developments that can degrade important brood-rearing habitat and or facilitate the spread of WNv. Additionally, some research suggests there may be direct competition between sage-grouse and livestock for plant resources. However, although there are obvious negative impacts, some research suggests that under very specific conditions grazing can benefit sage-grouse.

Similar to domestic grazing, wild horses and burros have the potential to negatively affect sage-grouse habitats in areas where they occur by decreasing grass cover, fragmenting shrub canopies, altering soil characteristics, decreasing plant diversity, and increasing the abundance of invasive *Bromus tectorum*.

Native ungulates have coexisted with sage-grouse in sagebrush ecosystems. Elk and mule deer browse sagebrush during the winter and can cause mortality to small patches of sagebrush from heavy winter use. Pronghorn antelope, largely overlapping with sage-grouse habitat year around, consume grasses and forbs during the summer and browse on sagebrush in the winter. We are not aware of research analyzing impacts from these native ungulates on sage-grouse or sage-grouse habitat.

Currently there is little direct evidence linking grazing practices to population levels of greater sage-grouse. However, testing for impacts of grazing at landscape scales important to sage-grouse is confounded by the fact that almost all sage-grouse habitat has at one time been grazed and thus no non-grazed, baseline areas currently exist with which to compare (Knick *et al.* in press, p. 43). Although we cannot examine grazing at large spatial scales, we do know that grazing can have negative impacts to sagebrush and consequently to sage-grouse at local scales. However, how these impacts operate at large spatial scales and thus on population levels is currently unknown. Given the widespread nature of grazing, the potential for population-level impacts cannot be ignored.

Energy Development

Greater sage-grouse populations are negatively affected by energy development activities (primarily oil, gas, and coal-bed methane), especially those that degrade important sagebrush habitat, even when mitigative measures are implemented (Braun 1998, p. 144; Lyon 2000, pp. 25-28; Holloran 2005, pp. 56-57; Naugle *et al.* 2006, pp. 8-9; Walker *et al.* 2007a, p. 2651; Doherty *et al.* 2008, p. 192; Harju *et al.* in press, p. 22). Impacts can result from direct habitat loss, fragmentation of important habitats by roads, pipelines, and powerlines (Kaiser 2006, p. 3; Holloran *et al.* 2007, p. 16), noise (Holloran 2005, p. 56), and direct human disturbance (Lyon and Anderson 2003, p. 489). The negative effects of energy development often add to the impacts from other human development and activities and result in sage-grouse population declines (Harju *et al.* in press, p. 22; Naugle *et al.*, in press, p. 1). For example, 12 years of coal-bed methane gas development in the Powder River Basin of Wyoming has coincided with 79 percent decline in the sage-grouse population (Emmerich 2009, pers. comm.). Population declines associated with energy development result from the abandonment of leks (Braun *et al.* 2002, p. 5; Walker *et al.* 2007a, p. 2649; Clark *et al.* 2008, pp. 14, 16), decreased attendance at the leks that persist (Holloran 2005, pp. 38-39, 50; Kaiser 2006, p. 23; Walker *et al.* 2007a, p. 2648; Harju *et al.* in press, p. 22), lower nest initiation (Lyon 2000, p. 109; Lyon and Anderson 2003, p. 5), poor nest success

and chick survival (Aldridge and Boyce 2007, p. 517), decreased yearling survival (Holloran *et al.*, in press, p. 6), and avoidance of energy infrastructure in important wintering habitat (Doherty *et al.* 2008, pp. 192-193).

Nonrenewable Energy Sources

Nonrenewable fossil fuel energy development (e.g., petroleum products, coal) has been occurring in sage-grouse habitats since the late 1800s (Connelly *et al.* 2004, p. 7-28). Interest in developing oil and gas resources in North America has been cyclic based on demand and market conditions (Braun *et al.* 2002, p. 2). Between 2004 and 2008, the exploration and development of fossil fuels in sagebrush habitats increased rapidly as prices and demand were spurred by geopolitical uncertainties and legislative mandates (National Petroleum Council 2007, pp. 5-7). Legislative mandates that were used to effect an increase in energy development include those of the Energy Policy and Conservation Act (EPCA) of 1975 (42 United States Code (U.S.C.) 6201 *et seq.*) to secure energy supplies and increase the availability of fossil fuels. Reauthorization and amendments to the EPCA have occurred through subsequent legislation including the Energy Policy Act of 2000 (Public Law (P.L.) 106-469) that mandates the inventory of Federal nonrenewable resources (42 U.S.C. 6217). The 2005 Energy Policy Act requires identification and resolution of impediments to timely granting of Federal leases and post-leasing development (42 U.S.C. 15851). In addition, the 2005 Energy Policy Act mandated the designation of corridors on Federal lands for energy transport (42 U.S.C. 15926), ordered the identification of renewable energy sources (e.g., wind, geothermal), and provided incentives for development of renewable energy sources (42 U.S.C. 15851).

Global recession starting in 2008 resulted in decreased energy demand and subsequently slowed rate of energy development (Energy Information Administration (EIA) 2009b, p. 2). However, the production of fossil fuels is predicted to regain and surpass the early 2008 levels starting in 2010 (EIA 2009b, p. 109). Forecasts to the year 2030 predict fossil fuels to continue to provide for the United States' energy needs while not necessarily in conventional forms or from present extraction techniques (EIA 2009b, pp. 2-4, 109). Recent concerns about curbing greenhouse gas emissions associated with fossil fuel use are being addressed through government policy, legislation, and advanced technologies and are likely to effect a transition in fuel form (EIA 2009b, pp. 2-3, 78).

The decline in use of conventional fossil fuels for power generation in the future is expected to be supplemented with biomass, unconventional oil and gas, and renewable sources—all of which are existing or potentially available in current sage-grouse habitats (U.S. Department of Energy (DOE) 2006, p. 3; National Petroleum Council 2007, p. 6; BLM 2005a, p. 2-4; National Renewable Energy Laboratory (NREL) 2008a, entire; Idaho National Engineering and Environmental Laboratory 2003, entire; EIA 2009b, pp. 2-4). For example, oil shale and tar sands are unconventional fossil fuel liquids predicted for increased development in the sage-grouse range. Shale sources providing 2 million barrels per day in 2007 are expected to contribute 5.6–6.1 million barrels by 2030 (EIA 2009b, p. 30). Extraction of this resource involves removal of habitat and disturbance similar to oil and gas development (see discussion below). National reserves of oil shale lie primarily in the Uinta–Piceance area of Colorado and Utah (MZs II, III, and VII), and the Green River and Washakie areas of southwestern Wyoming (MZ II). These 1.4 million ha (3.5 million ac) of Federal lands contain an estimated 1.23 trillion barrels of oil—more than 50 times the United States' proven conventional oil reserves (BLM 2008a, p. 2).

Available EPCA inventories detail energy resources in 11 geological basins (DOI *et al.* 2008, entire) in the greater sage-grouse conservation assessment area identified in the 2006 Conservation Strategy (Stiver *et al.* 2006, p. 1-11). Extensive oil and gas reserves are identified in the Williston Basin of western North Dakota, northwestern South Dakota, and eastern Montana; Montana Thrust Belt in west-central Montana; Powder River Basin of northeastern Wyoming and southeastern Montana; Wyoming Thrust Belt of extreme southwestern Wyoming, northern Utah, and southeastern Idaho; Southwest Wyoming Basin including portions of southwestern and central Wyoming, northeastern Utah, and northwestern Colorado; Uinta–Piceance Basin of west-central Colorado and east-central Utah; Eastern Great Basin in eastern Nevada, western Utah, and southern Idaho; and Paradox Basin in south-central and southeastern Utah. Although all these geological basins have some component of sage habitats, the Southwestern Wyoming Basin as defined by EPCA (DOI *et al.* 2008, p. 3-11) is highest in sagebrush-dominated landscapes (Knick *et al.* 2003, pp. 613, 615) and is located in MZ II as described in Stiver *et al.* 2006 (pp. 1-11).

Oil and gas development has occurred in the past, with historical well locations concentrated in MZs I, II, III, and VII of Wyoming, eastern Montana, western Colorado, and eastern Utah (IHS Incorporated 2006). Currently, oil, conventional gas, or coal-bed methane development occur across the eastern component of the SGCA. Four geological basins are most affected by a concentration of development—Powder River (MZ I), Williston (MZ I), Southwestern Wyoming (MZ II), and the Uinta–Piceance (MZs II, III, VII) coinciding with the highest proportion of high-density areas of sage-grouse, the greatest number of leks, and the highest male sage-grouse attendance at leks compared with any other area in the eastern part of the range (Doherty *et al.* in press, p. 11). The Powder River Basin in northeastern Wyoming and southeastern Montana is home to an important regional population of the larger Wyoming Basin populations, which represents 25 percent of the sage-grouse in the species' range (Connelly *et al.* 2004, p. A4-37). The Powder River Basin serves as a link to peripheral populations in eastern Wyoming and western South Dakota and between the Wyoming Basin and central Montana. The Pinedale Anticline Project is in the Greater Green River area of the Southwest Wyoming Basin where the subpopulation in southwestern Wyoming and northwestern Colorado has been a stronghold for sage-grouse with some of the highest estimated densities of males per square kilometer anywhere in the remaining range of the species (Connelly *et al.* 2004, pp. 6-62, A5-23). The southwestern Wyoming-northwestern Colorado subpopulation has historically supported more than 800 leks (Connelly *et al.* 2004, p. 6-62). The preservation of large contiguous blocks or interconnected patches of habitats that exist in southwestern Wyoming is considered a conservation priority for sage-grouse (Knick and Hanser in press, p. 31).

Extensive development and operations are occurring in sage-grouse habitats where the number of producing wells has tripled in the past 30 years (Naugle *et al.*, in press, p. 17). More than 8 percent of the distribution of sagebrush habitats is directly or indirectly affected by oil and gas development and associated pipelines (Knick *et al.* in press, p. 48). Forty-four percent of the 16-million-ha (39-million-ac) Federal mineral estate in MZs I and II is leased and authorized for exploration and development (Naugle *et*

al. in press, pp. 17-18). Wyoming contains the highest percentage of the Federal mineral estate with 10.6 million ha (26.2 million ac); 52 percent of it is authorized for development (Naugle *et al.*, in press, pp. 17-18). Other Federal mineral estates in the eastern portion of the sage-grouse conservation assessment area that are authorized for development include at least 27 percent of Montana's 3.7 million ha (9.1 million ac), 50 percent of 915,000 ha (2.3 million ac) in Colorado, 25 percent of 405,000 ha (1.0 million ac) in Utah, and 14 percent of North and South Dakota's combined 365,000 ha (902,000 ac) (Naugle *et al.* in press, p. 38).

The Great Plains MZ (MZ I) contains all or portions of the 20.9-million-ha (51.7-million-ac) Powder River and Williston geological basins identified as significant oil and gas resources. The resource areas include 7.2 million ha (18.2 million ac) of sagebrush habitats. Oil and gas infrastructure and planned development occupies less than 1 percent of the land area in MZ I; however, the ecological effect is greater than 20 percent of the sagebrush habitat, based on applying a buffer zone to estimate the potential the distance of sage-grouse response to infrastructure (Lyon and Anderson 2003, p. 489; Knick *et al.*, in press, p. 133). Energy development is concentrated in the Powder River geologic basin in northeastern Wyoming and southeastern Montana. Coal-bed natural gas extraction is the most recent development in the Powder River Basin, which also is the largest actively producing coal basin in the United States (Wyoming Mining Association 2008, p. 2).

In 2002, the BLM in Wyoming proposed development of 39,367 coal-bed methane wells and 3,200 conventional oil or gas wells in the Powder River Basin in addition to an existing 12,024 coal-bed methane wells drilled or permitted (BLM 2002, pp. 2-3). Wells would be developed over a 10–year period with production lasting until 2019 (BLM 2002, p. 3). The BLM estimated 82,073 ha (202,808 ac) of surface disturbance from all activities such as well pads, pipelines, roads, compressor stations, and water handling facilities over a 3.2-million-ha (8-million-ac) project area (BLM 2002, p. 2). Roads and water handling facilities were expected to be long-term disturbances encompassing approximately 38,501 ha (95,140 ac) (BLM 2002, p. 3). Reclamation of well sites was expected to be complete by 2022 (BLM 2002, p. 3). It is not clear if this 2022 date takes into consideration the length of time necessary to achieve suitable habitat conditions for sage-grouse or if restoration of sage-grouse habitat is possible.

Between 1997 and 2007, approximately 35,000 producing wells were in place on Federal, State, and private holdings in the Powder River Basin area (Naugle *et al.*, in press, p. 7). In 2008, the BLM in Montana completed a supplement to the 2003 Environmental Impact Statement (EIS) and Record of Decision (ROD) to allow for 5,800–16,500 new coal bed methane wells in the Montana portion of the Powder River Basin over the pursuant 20 years (BLM 2008b, pp. 4.2, 4.4-4.5). The BLM estimated a direct impact of 0.8–1.3 ha (2–3.4 ac) per well site (BLM 2008b, p. 4.11). In addition to the well footprint, each additional group of 2–10 wells has been shown to increase the number of new roads, power lines, and other infrastructure (Naugle *et al.* in press, p. 7). Ranching, tillage agriculture, and energy development are the primary land uses in the Powder River Basin. The presence of human features and road densities are high in areas where all three activities coincide to the level that every 0.8 ha (0.5 mi) could be bounded by a road and bisected by a power line (Naugle *et al.* in press, p. 9).

The Powder River Basin serves as a link to peripheral sage-grouse populations in eastern Wyoming and western South Dakota and between the Wyoming basin and central Montana. This connectivity is expected to be lost in the near future because of the intensity of development in the region. Sage-grouse populations have declined in the Powder River Basin by 79 percent since the development of coal-bed methane resources (Emmerich 2009, pers. comm.). In the Powder River Basin between 2001 and 2005, sage-grouse lek-count indices declined by 82 percent inside gas fields compared to 12 percent outside development (Walker *et al.* 2007a, p. 2648). By 2004–2005, fewer leks remained active (38 percent) inside gas fields compared to leks outside fields (84 percent) (Walker *et al.* 2007a, p. 2648). Sage-grouse are less likely to use suitable wintering habitat with abundant sagebrush when coal-bed methane development is present (Doherty *et al.* 2008, p. 192). At current maximum permitted well density (12 wells per 359 ha (888 ac)), planned full-field development will impact the remaining wintering habitat in the basin (Doherty *et al.* 2008, pp. 192, 194) and lead to extirpation.

Energy development in the Powder River Basin is predicted to continue to actively reduce sage-grouse populations and sagebrush habitats over the next 20 years based on the length of development and production projects described in existing project and management plans. The BLM concluded that sage-grouse habitats would not be restored to pre-disturbance conditions for an extended time (BLM 2003, p. 4-268). Sagebrush restoration after development is difficult to achieve, and successful restoration is not assured as described above (Habitat Description and Characteristics).

The 9.6-million-ha (23.9-million-ac) Williston Basin underlies the northeastern corner of the current sage-grouse range in Montana, North and South Dakota. It is another energy resource area experiencing concentrated oil and gas development in MZ I. Oil production has occurred in the Williston Basin for at least 80 years with oil production peaking in the 1980s (Advanced Resources International 2006, p. 3-3). Advances in technology including directional drilling and coal-bed methane technology have boosted development of oil and gas in the basin (Advanced Resources International 2006, p. 3.2; Zander 2008, p. 1). Large, developed fields are concentrated in the Bowdoin Dome area of north-central Montana and the 193-km (120-mi) long Cedar Creek Anticline area of southeastern Montana, southwestern North Dakota, and northwestern South Dakota. Extensive energy development in the Cedar Creek Anticline area could be isolating the very small North Dakota population from sage-grouse populations in central Montana and the northern Powder River Basin.

One hundred and thirty-six wells were put into production in 2008–2009 in major oil and gas fields of the Williston Basin north of the Missouri River in the range of the Northern Montana sage-grouse population (Montana Department of Natural Resources 2009, entire) including the Bowdoin Dome area. The Bowdoin Dome area is populated by more than 1,500 gas wells with associated infrastructure, and an additional 1,200 new or replacement wells were approved in the remaining occupied active sage-grouse habitat (BLM 2008c, pp. 1, 3-127 to 3-129). Active drilling operations are expected to occur over 10–15 years, and gas production is expected to extend the project life 30–50 additional years (BLM 2008c, p. 1). The BLM's project description does not take into consideration the time period necessary to restore native sagebrush communities to suitability for sage-grouse. Energy extraction, ranching, and tillage agriculture coincide in this area of the State described by Leu and Hanser (in press, p. 44) as experiencing

high-intensity human activity that is consistent with lek loss and population decline (Wisdom *et al.*, in press, p. 23). Energy development in Montana has contributed to post-settlement sage-grouse range contraction and possibly the geographic separation of the existing subpopulations in northern Montana and Canada. Foreseeable development is expected to further reduce the remaining sage-grouse habitat within developed oil and gas fields, and contribute to future range and population reductions (Copeland *et al.* 2009, p. 5).

Southwestern and central Wyoming and northwestern Colorado in MZ II has been considered a stronghold for sage-grouse with some of the highest estimated densities of males anywhere in the remaining range of the species (Connelly *et al.* 2004, pp. 6-62, A5-23). Wisdom *et al.* (in press, p. 23) identified this high-density sagebrush area as one of the highest priorities for conservation consideration as it comprises one of two remaining areas of contiguous range essential for the long-term persistence of the species. The Southwestern Wyoming geological basin also is experiencing significant growth in energy development which, based on the conclusions of recent investigations on the effects of oil and gas development, is expected over time to reduce sage-grouse habitat, increase fragmentation, and decrease and isolate sage-grouse populations leading to extirpations.

Oil, gas, and coal-bed methane development is occurring across MZ II, and development is concentrated in some areas. Intensive development and production is occurring in the Greater Green River area in southwestern Wyoming and northern Colorado and northeastern Utah. The BLM published a ROD in 2000 for the Pinedale Anticline Project Area in southwestern Wyoming (BLM 2000, entire). The project description included up to 900 drill pads, including dry holes, over a 10- to 15–year development period (BLM 2008d, p. 4-4). By the end of 2005, approximately 457 wells on 322 well pads were under production (BLM 2008d, p. 6). In 2008, the BLM amended the project to accommodate an accelerated rate of development exceeding that in the 2002 project description (BLM 2008d, p. 4). Approximately 250 new well pads are proposed in addition to pipelines and other facilities (BLM 2008d, p. 36). Total initial direct disturbance acres for the entire Pinedale project are approximately 10,400 ha (25,800 ac) with more than 7,200 ha (18,000 ac) in sagebrush land cover type (BLM 2008d, p. 4-52).

The Jonah Gas Infill Project also is underway in the Pinedale Anticline area of the Southwest Wyoming Basin that expands on the Jonah Project started in 2000. In 2006, the BLM issued a ROD and EIS to extend the existing project to an additional 3,100 wells and up to 6,556 ha (16,200 ac) of new surface disturbance (BLM 2006, p. 2-4). In addition, at least 64 well pads would be situated per 259 ha (640 ac), and up to 761 km (473 mi) of pipeline and roads, 56 ha (140 ac) of additional disturbance for ancillary facilities (p. 2-5) also would occur. The project life of 76 years includes 13 years of development and 63 years of production (BLM 2006, p. 2-15). The project description requires reclamation of disturbed sites and establishment of stabilizing vegetation by 1 year post-reclamation (BLM 2006, p. 2-24) and standard lease stipulations to protect sage-grouse. This project is located in high-density sage-grouse habitat, but it is not clear from the project description if suitable sage-grouse habitat is the reclamation goal. Therefore, sagebrush habitats, and the associated sage-grouse are likely to be lost.

Knick *et al.* (in press, pp. 49, 128) reviewed BLM documents for the Greater Green River Basin area, which includes the Pinedale and Jonah projects, and reported that 6,185 wells have been drilled, and there are agency plans for more than 9,300 wells and associated infrastructure. Existing and planned energy development influences over 20 percent of the sagebrush area in the Wyoming Basin (MZ II) (Knick *et al.*, in press, p. 133). Drilling, gas production, and traffic on main haul roads have all been shown to affect lek attendance and lek persistence when it coincides with breeding habitat within 3.2 km (2 mi) (Holloran 2005, p. 40; Walker *et al.* 2007a, p. 2651). Using 2006 well point data and, therefore, a conservative estimate as oil exploration and development experienced significant growth between 2006 and 2008, we calculated that 21 to 35 percent of active breeding habitat for subpopulations in the Southwest Wyoming geological basin may be negatively impacted by the proximity of energy development (Service 2008b).

In the Greater Green River Basin area, yearling male sage-grouse reared near gas field infrastructure had lower survival rates and were less likely to establish breeding territories than males with less exposure to energy development; yearling female sage-grouse avoided nesting within 950 m (0.6 mi) of natural gas infrastructure (Holloran *et al.*, in press, p. 6). The fidelity of sage-grouse to natal sites may result in birds staying in areas with development but they do not breed (Lyon and Anderson 2003, p. 49; Walker *et al.* 2007a, p. 2651; Holloran *et al.*, in press, p. 6). The effect of energy development on sage-grouse population numbers may then take 4 to 5 years to appear (Walker *et al.* 2007a, p. 2651). Copeland *et al.* (2009, p. 5) depicted an extensive development scenario for southwest Wyoming, northern Colorado, and northeastern Utah based on known reserves and existing project plans that indicates an intersection between future oil and gas development and high-density sage-grouse core areas that could result in 6.3 to 24.1 percent decrease in sage-grouse numbers over the next 20 years in MZ II (Copeland 2010, pers. comm.).

The Greater Green River area of southwest Wyoming and the Uintah–Piceance basin (discussed below) also are, in addition to oil and gas, important reserves of oil shale and tar sands that are expected to supply more of the nation's resource needs in the future (EIA 2009b, p. 30). The Uintah–Piceance geologic basin includes the Colorado Plateau (MZ VII) and overlaps into the southern edge of the Wyoming Basin (MZ II). Sage-grouse in this part of the range are reduced to four small, isolated populations, a likely consequence of urban and agricultural development (Knick *et al.*, in press, pp. 106-107; Leu and Hanser, in press, p. 15). All four populations are threatened by environmental, demographic, and genetic stochasticity due to their small population sizes as well as housing and energy development, predation, disease, and conifer invasion (Garton *et al.*, in press, p. 7; Petch 2009, pers. comm.; Maxfield 2009, pers. comm.) although population data are limited for most of this area (Garton *et al.*, in press, p. 63).

Based on applying a 3 km (1.9 mi) buffer to construction areas, Knick *et al.* (in press, p. 133) estimate existing energy development affects over 30 percent of sagebrush habitats in this area. In the past 4 years, the number of oil and gas wells increased in sage-grouse habitats of northwestern Colorado and northeastern Utah by 325 and 870 wells, respectively (Service 2008c). More than 1,370 wells were completed in Uintah (location of the two Utah populations) and Duchesne Counties of northeast Utah between July 2008 and August 2009 (Utah Oil and Gas Program 2009, entire), and approximately 7,700 wells are active in the counties (Utah DNRC 2009, entire). We expect that the development of energy resources will continue based on

available reserves and recent development history (Copeland *et al.* 2009, p. 5), and development will further stress the persistence of these small populations at the southern edge of the sage-grouse range.

Using GIS analysis, we calculated that 70 percent of the sage-grouse breeding habitat is potentially impacted by oil and gas development in the Powder River Basin (Service 2008b). The 70 percent figure was derived from well point data supplied by the BLM, buffered by 3.2 km (2 mi), and intersecting these areas with known lek locations buffered to 6.4 km (4 mi). The 70 percent figure is conservative because the most comprehensive well point data set available was 2 years old and did not reflect the rapid development that occurred in 2008. Breeding habitat is defined as a 6.4-km (4-mi) radius around known lek points and includes the range of the average distances between nests and nearest lek (Autenrieth 1981, p. 18; Wakkinen *et al.* 1992, p. 2).

The effects of oil and gas development, as described in detail later in this section, are likely to continue for decades even with the current protective or mitigative measures in place. Based on a review of project EISs, Connelly *et al.* (2004, p. 7-41) concluded that the economic life of a coal-bed methane well averages 12–18 years and 20–100 years for deep oil and gas wells. A recent review of energy projects in development, primarily gas and coal-bed methane, supports these timeframes (BLM 2008b, p. 4-2; 2008c, p. 2; 2009b, p. 2). In addition, many energy projects are tiered to the 20–year land use plans developed by individual BLM field offices or districts to guide development and other activities.

The BLM is the primary Federal agency managing the United States' energy resources and has the legal authority to regulate and condition oil and gas leases and permits. Although the restrictive stipulations that BLM applies to permits and leases are variable, a 0.4-km (0.25-mi) radius around sage-grouse leks is generally restricted to no surface occupancy (NSO) during the breeding season, and noise and development activities are often limited during the breeding season within a 0.8- to 3.2-km (0.5 to 2-mi) radius of sage-grouse leks. As stated above, the BLM's NSO buffer stipulation is ineffective in protecting sage-grouse (Walker *et al.* 2007a, p. 2651), and it is not applied or applicable to all development sites (see discussion under Factor D). We estimated the sage-grouse breeding habitat impacted within 0.4 km (0.25 mi) of a producing well or drilling site with an approved BLM permit using 2006 well-site locations (the most comprehensive data available to us). Figures derived from the 2006 data are conservative because the rapid pace of development in 2007 and 2008 is not reflected. Within 16.2 million ha (38 million ac) of sage-grouse breeding habitat in MZs I and II (where 65 percent of all sage-grouse reside), approximately 1.7 million ha (4.2 million ac) or 10 percent are within 0.4 km (0.25 mi) of a producing well, drilling operation or site (Service 2008d). Walker *et al.* (2007a, p. 2651) reported negative impacts on lek attendance of coal-bed methane development within 0.8 km (0.5 mi) and 3.2 km (2 mi) of a lek, and Holloran (2005, pp. 57-60) observed that the influence of producing well sites and mail haul roads on lek attendance extended to at least 3 km (2 mi). Expanding our analysis area from 0.4 km (0.25 mi) to include breeding habitat within 3 km (2 mi) of producing well or drilling sites with an approved BLM permit, we determined that 40 percent of the sage-grouse breeding habitat in MZs I and II is potentially affected by oil or gas development (Service 2008b).

In some cases, localized areas are experiencing higher levels of effects. Seventy percent of the sage-grouse breeding habitat is within 3 km (2 mi) of development in the Powder River Basin of northeastern Wyoming and southeastern Montana (Service 2008b), where Walker *et al.* (2007, p. 2651) concluded that full-field development would reduce the probability of lek persistence from 87 to 5 percent. Our analyses show that subpopulations of sage-grouse in MZ II have up to 35 percent of breeding habitat within 3.2 km (2 mi) of development, and where data are available for populations in the Uintah–Piceance Basin of Colorado and Utah, 100 percent of the breeding habitat is affected by oil and gas development (Service 2008b). Additionally these calculations do not take into account the added effects of loss of habitat or habitat effectiveness resulting from the increasing level of renewable energy development or other anthropogenic factors occurring in concert with oil and gas development, such as agricultural tillage, urban expansion, or predation, fire, and invasives (see discussions under those headings).

Energy development impacts sage-grouse and sagebrush habitats through direct habitat loss from well pad, access construction, seismic surveys, roads, powerlines, and pipeline corridors; indirectly from noise, gaseous emissions, changes in water availability and quality, and human presence; and the interaction and intensity of effects could cumulatively or individually lead to fragmentation (Suter 1978, pp. 6-13; Aldridge 1998, p. 12; Braun 1998, pp. 144-148; Aldridge and Brigham 2003, p. 31; Knick *et al.* 2003, pp. 612, 619; Lyon and Anderson 2003, pp. 489-490; Connelly *et al.* 2004, pp. 7-40 to 7-41; Holloran 2005, pp. 56-57; Holloran 2007, pp. 18-19; Aldridge and Boyce 2007, pp. 521-522; Walker *et al.* 2007a, pp. 2652-2653; Zou *et al.* 2006, pp. 1039-1040; Doherty *et al.* 2008, p. 193; Leu and Hanser, in press, p. 28).

The development of oil and gas resources requires surveys for economically recoverable reserves, construction of well pads and access roads, subsequent drilling and extraction, and transport of oil and gas, typically through pipelines. Ancillary facilities can include compressor stations, pumping stations, electrical generators, and powerlines (Connelly *et al.* 2004, p. 7-39; BLM 2007c, p. 2-110). Surveys for recoverable resources occur primarily through seismic activities, using vibroesis buggies (thumpers) or shothole explosives. Well pads vary in size from 0.10 ha (0.25 ac) for coal-bed natural gas wells in areas of level topography to greater than 7 ha (17.3 ac) for deep gas wells and multiwell pads (Connelly *et al.* 2004, p. 7-39; BLM 2007c, p. 2-123). Pads for compressor stations require 5–7 ha (12.4–17.3 ac) (Connelly *et al.* 2004, p. 7-39).

Well densities and spacing are typically designed to maximize recovery of the resource and are administered by State oil and gas agencies and the BLM, the Federal agency charged with administering the nation's Federal mineral estate (Connelly *et al.* 2004 pp. 7-39 to 7-40). Well density on BLM-administered lands is incorporated in land use plans and often based on the spacing decision of individual State oil and gas boards. Each geologic basin has a standard spacing, but exemptions are granted. Density of wells for current major developments in the sage-grouse range vary from 1 well per 2 ha (5ac) to 1 well per 64 ha (158 ac) (Knick *et al.*, in press, pp. 128). Greater sage-grouse respond to the density and distribution of infrastructure on the landscape. Holloran (2005, pp. 38-39, 50) reported that male sage-grouse attendance at leks decreased over 23 percent in gas fields where well density was 5 or more within 3 km (1.9 mi). Sage-grouse are less likely to occupy areas with wells at a 32 ha (80 ac) spacing than a 400 ha (988 ac) spacing (Doherty *et al.* 2008, p. 193).

Direct habitat loss from the human footprint contributes to decreased

population numbers and distribution of the greater sage-grouse (Knick *et al.* 2003, p. 1; Connelly *et al.* 2004, p. 7-40; Aldridge *et al.* 2008, p. 983; Copeland *et al.* 2009, p. 6; Knick *et al.*, in press, p. 60; Leu and Hanser, in press, p. 5). The footprint of energy development contributes to direct habitat loss from construction of well pads, roads, pipelines, powerlines, and through the crushing of vegetation during seismic surveys. The amount of direct habitat loss within an area is ultimately determined by well densities and the associated loss from ancillary facilities.

The ecological footprint is the extended effect of the infrastructure or activity beyond its physical footprint and determined by a physical or behavioral response of the sage-grouse. The physical footprint of oil and gas infrastructure including pipelines is estimated to be 5 million ha (1.2 million ac) and less than 1 percent of the SGCA (Knick *et al.*, in press, p. 133). However, the estimated ecological footprint is more than 13.8 million ha (34.2 million ac) or 6.7 percent of the SGCA (Knick *et al.*, in press, p. 133) based on applying a buffer zone to estimate potential avoidance, increased mortality risk, and lowered fecundity in the vicinity of development (Lyon and Anderson 2003, p. 459; Walker *et al.* 2007a, p. 2651; Holloran *et al.* in press, p. 6). Based on their method, Knick *et al.* (in press, p. 133) estimated more than 8 percent of sagebrush habitats within the SGCA are affected by energy development. The MZs with concentrations of oil and gas development have a higher estimated percentage of sagebrush habitats affected: 20 percent of the Great Plains (MZ I), 20 percent of the Wyoming Basin (MZ II), and 29 percent of the Colorado Plateau (MZ VII) (Knick *et al*, in press, p. 133). Copeland *et al.* (2009, p. 6) predict a scenario with a minimum of 2.3 million additional ha (5.7 million ac) directly impacted by oil and gas development by the year 2030. The corresponding ecological footprint is likely much larger. The projected increase in oil and gas energy development within the sage-grouse range could reduce the population by 7 to 19 percent from today's numbers (Copeland *et al.* 2009, p. 6). This projection does not reflect the effects of the increased development of renewable energy sources.

Roads associated with oil and gas development were suggested to be the primary impact to greater sage-grouse due to their persistence and continued use even after drilling and production ceased (Lyon and Anderson 2003, p. 489). Declines in male lek attendance were reported within 3 km (1.9 mi) of a well or haul road with a traffic volume exceeding one vehicle per day (Holloran 2005, p. 40; Walker *et al.* 2008a, p. 2651). Sage-grouse also may be at increased risk for collision with vehicles simply due to the increased traffic associated with oil and gas activities (Aldridge 1998, p. 14; BLM 2003, p. 4-222).

Habitat fragmentation resulting from oil and gas development infrastructure, including access roads, may have effects on sage-grouse greater than the associated direct habitat losses. The Powder River Basin infrastructure footprint is relatively small (typically 6-8 ha per 2.6 km^2 (15-20 ac per section)). Considering the mostly contiguous nature of the project area, the density of facilities could affect sage-grouse habitats on over 2.4 million ha (5.9 million ac). Energy development and associated infrastructure works cumulatively with other human activity or development to decrease available habitat and increase fragmentation. Walker *et al.* (2007, p. 2652) determined that leks had the lowest probability of persisting (40–50 percent) in a landscape with less than 30 percent sagebrush within 6.4 km (4 mi) of the lek. These probabilities were even less in landscapes where energy development also was a factor.

Noise can drive away wildlife, cause physiological stress, and interfere with auditory cues and intraspecific communication. Aldridge and Brigham (2003, p. 32) reported that, in the absence of stipulations to minimize the effects of noise, mechanical activities at well sites may disrupt sage-grouse breeding and nesting activities. Hens bred on leks within 3 km (1.9 mi) of oil and gas development in the upper Green River Basin of Wyoming selected nest sites with higher total shrub canopy cover and average live sagebrush height than hens nesting away from disturbance (Lyon 2000, p. 109). The author hypothesized that exposure to road noise associated with oil and gas drilling may have been one cause for the difference in habitat selection. However, noise could not be separated from the potential effects of increased predation resulting from the presence of a new road. In the Pinedale Anticline area of southwest Wyoming, lek attendance declined most noticeably downwind from a drilling rig indicating that noise likely affected male presence (Holloran 2005, p. 49).

Above-ground noise is typically not regulated to mitigate effects to sage-grouse or other wildlife (Connelly *et al.* 2004, p. 7-40). Ground shock from seismic activities may affect sage-grouse if it occurs during the lekking or nesting seasons (Moore and Mills 1977, p. 137). We are unaware of any research on the impact of ground shock to sage-grouse.

Water quality and quantity may be affected by oil and gas development. In many large field developments, the contamination threat is minimized by storing water produced by the gas dehydration process in tanks. Water also may be depleted from natural sources for drilling or dust suppression purposes. Concentrating wildlife and domestic livestock may increase habitat degradation at remaining water sources. Negative effects of changes in water quality, availability, and distribution are a reduction in habitat quality (e.g., trampling of vegetation, changes in water filtration rates), and habitat degradation (e.g., poor vegetation growth), which could result in brood habitat loss. However, we have no data to suggest that this, by itself, is a limiting factor to sage-grouse.

Water produced by coal-bed methane drilling may benefit sage-grouse through expansion of existing riparian areas and creation of new areas (BLM 2003, p. 4-223). These habitats could provide additional brood rearing and summering habitats for sage-grouse. However, the increased surface-water on the landscape may negatively impact sage-grouse populations by providing an environment for disease vectors (Walker and Naugle in press, p. 13). Based on the 2002 discovery of WNv in the Powder River Basin, and the resulting mortalities of sage-grouse (Naugle *et al.* 2004, p. 705), there is concern that produced water could have a negative impact if it creates suitable breeding reservoirs for the mosquito vector of this disease (see also discussion in Factor C, Disease and Predation). Produced water also could result in direct habitat loss through prolonged flooding of sagebrush areas, or if the discharged water is of poor quality because of high salt or other mineral content, either of which could result in the loss of sagebrush or grasses and forbs necessary for foraging broods (BLM 2003, p. 4-223).

Air quality could be affected where combustion engine emissions, fugitive dust from road use and wind erosion, natural gas-flaring, fugitive emissions from production site equipment, and other activities (BLM 2008d, p. 4-74) occur in sage-grouse habitats. Presumably, as with surface mining, these emissions are quickly dispersed in the windy, open conditions of sagebrush habitats (Moore and Mills 1977, p. 109), minimizing the potential effects on sage-grouse. However, high-density development could produce airborne pollutants that reach or exceed quality

standards in localized areas for short periods of time (BLM 2008d, pp. 4-82 to 4-88). Walker (2008, entire) characterized emissions from well flaring in the Pinedale Anticline area of Sublette County, Wyoming. The investigator suggested a comprehensive study be conducted by regulatory agencies of the potential health effects of alkali elements in combusted well-plume material (Walker 2008, entire). No information is available regarding the effects to sage-grouse of gaseous emissions produced by oil and gas development.

Increased human presence resulting from oil and gas development can impact sage-grouse either through avoidance of suitable habitat, disruption of breeding activities, or increased hunting and poaching pressure (Braun *et al.* 2002, pp. 4-5; Aldridge and Brigham 2003, pp. 30-31; Aldridge and Boyce 2007, p. 518; Doherty *et al.* 2008, p. 194). Sage-grouse also may be at increased risk for collision with vehicles simply due to the increased traffic associated with oil and gas activities (BLM 2003, p. 4-216).

Negative effects of direct habitat disturbance can be offset by successful reclamation. Reclamation of areas disturbed by oil and gas development can be concurrent with field development or conducted after the shut-in or abandonment of the well or field. Sage-grouse may repopulate the area as disturbed areas are reclaimed. However, there is no evidence that populations will attain their previous size, and reestablishment may take 20 to 30 years (Braun 1998, p. 144). For most developments, return to pre-disturbance population levels is not expected due to a net loss and fragmentation of habitat (Braun *et al.* 2002, p. 150). After 20 years, sage-grouse have not recovered to pre-development numbers in Alberta, even though well pads in these areas have been reclaimed (Braun *et al.* 2002, pp. 4-5). In some reclaimed areas, sage-grouse have not returned (Aldridge and Brigham 2003, p. 31).

Mining

Mining began in the range of the sage-grouse before 1900 (State of Wyoming, 1898; U.S. Census 1913, p. 187) and continues today. Currently, surface and subsurface mining activities for numerous resources are conducted in all 11 States across the sage-grouse range. We do not have comprehensive information on the number or surface extent of mines across the range, but the development of mineral resources is occurring in sage-grouse habitats and is important to the economies of a few of the States. Nevada (MZs III, IV, and V) is ranked second in the United States in terms of value of overall nonfuel mineral production in 2006 (USGS 2006, p. 10). Wyoming (MZs I and II) is the largest coal producer in the United States, and the top ten producing mines in the country are located in Wyoming's Powder River Basin (MZ I) (Wyoming Mining Association 2008, p. 2). A preliminary estimate of at least 9.9 km^2 (3.8 mi^2) of occupied sage-grouse habitat will be directly impacted by new or expanded mining operations, currently in the planning phase, for coal in Montana (MZ I) and Utah (MZ III), for phosphate in Idaho (MZ IV), and uranium in Nevada (MZ IV) and Wyoming (MZs I and II) (Service 2008b).

Uranium mining and milling has occurred in Wyoming, Utah, and Colorado, and Nevada within the greater sage-grouse conservation area; however, recent production has been very limited with only one operation in production in Wyoming (EIA 2009c, entire). Tax credits indicated in the 2005 Energy Policy Act and concerns for green-house gas emissions associated with fossil-fuel electricity generation are expected to increase nuclear power generation (EIA 2009b, p. 73) and stimulate the demand for uranium. Electricity supplied by nuclear plants is expected to increase 2–55 percent by 2030; the increase is dependent on variables such as construction costs and regulatory mandates (EIA 2009b, p. 52), which are difficult to predict. In 2009, industry announced the intent to pursue development (Peninsula Minerals 2009, entire), and the Nuclear Regulatory Commission announced the review of numerous new uranium facilities in Wyoming (74 FR 41174, Uaugust 14, 2009; 74 FR 45656, September 3, 2009). Areas in central Wyoming and Wyoming's Powder River Basin are considered major reserves of uranium coinciding with areas of high sage-grouse population densities (Finch 1996, pp. 19-20; Wyoming State Governor's Sage-grouse Implementation Team 2008, entire).

Bentonite mining has been conducted on over 85 km^2 (33 mi^2) in the Bighorn Basin of north-central Wyoming (EDAW, Inc. and BLM 2008, p. 1). Bentonite is a primary component of oil and gas drilling muds. The loss of sagebrush associated with bentonite mining has been intensive on a localized level and has contributed to altering 12 percent of the sagebrush habitats in the 2,173 km^2 (839 mi^2) Bighorn Basin (EDAW Inc., and BLM 2008, p. 2). Restoration efforts at mine sites have been mostly unsuccessful (EDAW, Inc. and BLM 2008, p. 1). The BLM foresees up to 89 additional km^2 (34 mi^2) to be disturbed by bentonite mining in the area through 2024, in addition to possible oil and gas and energy transmission disturbances (EDAW, Inc. and BLM 2008, p. 2; BLM 2009c, p. 5).

Between 2006 and 2007, surface coal production decreased 9 percent in Colorado while increasing by 1.6 and 4.4 percent in Wyoming (MZ I) and Montana (MZ I), respectively (EIA 2008a, entire). The number of Wyoming coal mines increased from 19 in 2005 to 23 in 2008 (Wyoming Mining Association 2005, p. 5). All of Wyoming's 23 coal mines are in sagebrush and in the SGCA. Sixteen of these mines are located in the Powder River Basin (MZ I) where oil and gas development is extensive (Wyoming Mining Association 2008, p. 2).

Coal mining in Montana is focused in the Powder River Basin just north of the Wyoming border, in sagebrush habitat. In Wyoming and Montana, an estimated 558 km^2 (215 mi^2) of sagebrush habitats have been disturbed by coal mines and associated facilities; disturbance increased approximately 170 km^2 (66 mi^2) between 2005 and 2007 (Service 2005, p. 75; Service 2008c; Wyoming Mining Association 2008, p. 7). Wyoming estimates that 275 km^2 ha (106 mi^2) of mine-disturbed land has been reclaimed (Wyoming Mining Association 2008, p. 7), but we have no knowledge of the effectiveness of these reclamation projects in providing functional sage-grouse habitat.

While western coal production has grown steadily since 1970, growth is predicted to increase through 2030, but at a much slower rate than in the past (EIA 2009b, p. 83). Coal production is projected to increase with the development of technology to reduce sulfur emissions and most of the future output of coal is expected from low-sulfur coal mines in Wyoming, Montana, and North Dakota (EIA 2009b, p. 83). We do not have information to quantify the footprint of future coal production; however, additional losses and deterioration of sage-grouse habitats are expected where mining activity occurs (described later in this section). The use of coal may be reduced if limitations on green-house gas emissions are enacted in the future. A transition would require development of lower emission sources, such as wind, solar, or nuclear, that may have their own impacts on sage-grouse environments.

Surface and subsurface mining for mineral resources (coal, uranium, copper, phosphate, aggregate, and others) results in direct loss of habitat if occurring in sagebrush habitats. The

direct impact from surface mining is usually greater than it is from subsurface activity. Habitat loss from both types of mining can be exacerbated by the storage of overburden (soil removed to reach subsurface resource) in otherwise undisturbed habitat. If the construction of mining infrastructure is necessary, additional direct loss of habitat could result from structures, staging areas, roads, railroad tracks, and powerlines. Sage-grouse and nests could be directly affected by trampling or vehicle collision. Sage-grouse also will likely be impacted indirectly from an increase in human presence, land use practices, ground shock, noise, dust, reduced air quality, degradation of water quality and quantity, and changes in vegetation and topography (Moore and Mills 1977, entire; Brown and Clayton 2004, p. 2).

An increase in human presence increases collision risk with vehicles and potentially exposes sage-grouse and other wildlife to pathogens introduced from septic systems and waste disposal (Moore and Mills 1977, pp. 114-116, 135). Water contamination also could occur from leaching of waste rock and overburden and nutrients from blasting chemicals and fertilizer (Moore and Mills 1977, pp. 115, 133). Altering of water regimes could lead to decreased surface water and eventual habitat degradation from wildlife or livestock concentrating at remaining sources. Sage-grouse do not require water other than what they obtain from plant resources (Schroeder *et al.* 1999, p. 6); therefore, local water quality deterioration or dewatering is not expected to have population-level impacts. Degradation of riparian areas could result in a loss of brood habitat.

Mining and associated activities creates an opportunity for invasion of exotic and noxious weed species that alter suitability for sage-grouse (Moore and Mills 1977, pp. 125, 129). Reclamation is required by State and Federal laws, but laws generally allow for a change in post-mining land use. Restoration of sagebrush is difficult to achieve and disturbed sites may never return to suitability for sage-grouse (refer to Habitat Description and Characteristics section).

Heavy equipment operations and use of unpaved roads produces dust that can interfere with plant photosynthesis and insect populations. Most large surface mines are required to control dust. Gaseous emissions generated from heavy equipment operation are quickly dispersed in open, windy areas typical of sagebrush (Moore and Mills 1977, p.109). Blasting, to remove overburden or the target mineral, produces noise and ground shock. The full effect of ground shock on wildlife is unknown. Repeated use of explosives during lekking activity could potentially result in lek or nest abandonment (Moore and Mills 1977, p. 137). Noise from mining activity could mask vocalizations resulting in reduced female attendance and yearling recruitment as seen in sharp-tailed grouse (*Pedioecetes phasianellus*) (Amstrup and Phillips 1977, pp. 23, 25-27). In this study, the authors found that the mining noise in the study area was continuous across days and seasons and did not diminish as it traveled from its source. The mechanism of how noise affects sage-grouse is not known, but it is known that sage-grouse depend on acoustical signals to attract females to leks (Gibson and Bradbury 1985, pp. 81-82; Gratson 1993, pp. 693-694). Noise associated with oil and gas development may have played a factor in habitat selection and a decrease in lek attendance by sage-grouse (Holloran 2005, pp. 49, 56).

A few scientific studies specifically examine the effects of coal mining on greater sage-grouse. In a study in North Park, Colorado, overall sage-grouse population numbers were not reduced, but there was a reduction in the number of males attending leks within 2 km (0.8 mi) of three coal mines, and existing leks failed to recruit yearling males (Braun 1986, pp. 229-230; Remington and Braun 1991, pp. 131-132). New leks formed farther from mining disturbance (Remington and Braun 1991, p. 131). Additionally, some leks that were abandoned adjacent to mine areas were reestablished when mining activities ceased, suggesting disturbance rather than habitat loss was the limiting factor (Remington and Braun 1991, p.132). Hen survival did not decline in a population of sage-grouse near large surface coal mines in northeast Wyoming, and nest success appeared not to be affected by adjacent mining activity (Brown and Clayton 2004, p. 1). However, the authors concluded that continued mining would result in fragmentation and eventually impact sage-grouse persistence if adequate reclamation was not employed (Brown and Clayton 2004, p.16).

Surface coal mining and associated activities have negative short-term impacts on sage-grouse numbers and habitats near mines (Braun 1998, p. 143). Sage-grouse will reestablish on mined areas once mining has ceased, but there is no evidence that population levels will reach their previous size, and any population reestablishment could take 20 to 30 years based on observations of disturbance in oil and gas fields (Braun 1998, p. 144). Local sage-grouse populations could decline if several leks are affected by coal mining, but the loss of one or two leks in a regional area was likely not limiting to local populations in the Caballo Rojo Mine in northeastern Wyoming based on the presence of viable habitat elsewhere in the region (Hayden-Wing Associates 1983, p. 81).

As described above, mining directly removes habitat, may interfere with auditory clues important to mate selection, and results in a decrease of males and inhibits yearling recruitment at leks in proximity to mining activity. Sage-grouse habitat reestablishment and recovery of population numbers in an area post-disturbance is uncertain. Similar avoidance of disturbance has been noted in recent investigations of oil and gas development in Wyoming and discussed in detail in the Nonrenewable Energy section. The studies recounted here were conducted on a local scale that provides limited insight into impacts at a larger landscape perspective. In Wyoming specifically, the cumulative impacts of surface coal mine disturbance, concurrent increases in oil and gas development, increased development of renewable energy resources (discussed in the following section), and transmission infrastructure development could have significant impacts on sage-grouse in the Powder River Basin. The Powder River Basin is home to an important regional population of the larger Wyoming Basin populations covering most of Wyoming, northwestern Colorado, and northeastern Utah (Connelly *et al.* 2004, pp. 6-62 to 6-63).

Renewable Energy Sources

The demand for electricity from renewable energy sources is increasing. Electricity production from renewable sources increased from 6.4 quadrillion British thermal units (Btu) in 2005 to 6.9 quadrillion Btu in 2006. Production was down slightly in 2007, but energy production by renewables reached 7.3 quadrillion Btu by the end of 2008 (EIA 2009d, entire). Wind, geothermal, solar and biomass are renewable energy sources developable in sage-grouse habitats. Large-scale hydropower generation occurs in the sage-grouse range in parts of Washington State. Conventional hydropower electrical generation has actually decreased over the past 10 years (EIA 2009d, entire). In general, growth of the renewable energy industry is predictable based on legislated mandates to achieve target levels of renewable-produced electricity in many States within the sage-grouse range.

Wind

Areas of commercially viable wind generation have been identified by the NREL (2008b, entire) and BLM (2005, p. 2.4) in all 11 States in the greater sage-grouse range.

MZs III through VII each have approximately 1 to 14 percent of sagebrush habitats that are commercially developable for wind energy (Service 2008e, entire). Wind harvesting potentials are more concentrated and geographically extensive in sage-grouse MZs I and II that include parts of Montana, Wyoming, North Dakota, and South Dakota; areas of highest commercial potential include 59 percent of the available sagebrush habitats in these four States. Over 30 percent of the sagebrush lands in the sage-grouse range have high potential for wind power (Table 8).

TABLE 8—AREA OF SAGEBRUSH HABITAT WITH WIND ENERGY DEVELOPMENT POTENTIAL, BY MANAGEMENT ZONE. (DATA FROM SERVICE 2008E)

SAGE-GROUSE MZ	Area of Sagebrush with Developable Wind Potential		
	km²	mi²	Percent of MZ
I	137,733	53,179	76.02
II	46,835	18,083	42.16
III	3,028	1,169	3.23
IV	12,952	5,001	9.05
V	5,532	2,136	8.27
VI	2,660	1,027	14.44
VII	199	77	1.10
TOTAL	208,939	80,672	33.02

Commercial viability is based on wind intensity and consistency, available markets and access to transmission facilities. Consequently, current development is focused in areas with existing power transmission infrastructure associated with urban development, preexisting conventional energy resource development (e.g., coal and natural gas) and power generation. Growth of wind power development is expected to continue even in the current economic climate (EIA 2009b, p. 3), spurred by statutory mandates or financial incentives to use renewable energy sources in all 11 States in the range (Association of Fish and Wildlife Agencies (AFWA) and Service 2007, pp. 7, 8, 14, 28, 30, 36, 39, 43, 46, 49, 52; State of Oregon 2008, entire).

Wind generating facilities have increased in size and number, outpacing development of other renewable sources in the sage-grouse range. The BLM, the major land manager in the sage-grouse range, developed programmatic guidance to facilitate the use of BLM land for wind development (BLM 2005a, entire). The BLM wind policy permits granting private right-of-ways and leasing of public land for 3–year monitoring and testing facilities and long-term (30 to 35 years) commercial generating facilities (American Wind Energy Association (AWEA) 2008, p. 4-24). Active leases for wind energy development on BLM lands increased from 9.7 km² (3.7 mi²) in 2002 to 5,113 km² (1,973 mi²) in 2008, and an additional 5,381 km² (2,077 mi²) of lease requests were pending approval in the sage-grouse range (Knick *et al.*, in press, p. 136).

A recent increase in wind energy development is most notable within the range of the south-central Wyoming subpopulation of greater sage-grouse in MZ II where 1,387 km² (535 mi²) have active wind leases and an additional 2,828 km² (1,092 mi²) are pending (Knick *et al.*, in press, p. 136). The south-central Wyoming subpopulation has a loose association with adjacent populations where there is accelerated oil, gas, and coal development in the State – the Powder River Basin (MZ I) to the northeast and Pinedale-Jonah Gas Fields in the southwest Wyoming Basin (MZ II) (Connelly *et al.* 2004, p. 6-62). As stated previously, the Powder River Basin is home to an important regional population of the larger Wyoming Basin populations (Connelly *et al.* 2004, p. 6-62). The subpopulation in southwest Wyoming and northwest Colorado is a stronghold for sage-grouse with some of the highest estimated densities of males anywhere in the remaining range of the species (Connelly *et al.* 2004, pp. 6-62, A5-23). The south-central Wyoming wind potential corridor is not only a geographical bridge between two important population areas but is home to a large population of sage-grouse (Connelly *et al.* 2004, p. A5-22) and core areas identified preliminarily as high density breeding areas for sage-grouse by the Wyoming State Governor's Executive Order (State of Wyoming 2008, entire). Although regulatory mechanisms are being developed for Wyoming's core areas (see regulatory mechanisms section below), they are still largely subject to the impacts of both conventional and renewable energy development. Twenty-one percent of Wyoming core areas have high wind development potential, and 51 percent are subject to either wind or authorized development of oil and gas leases (Doherty *et al.*, in press, p. 31).

In addition to Wyoming, southeastern Oregon is a focus area for potential commercial-scale wind development. Currently, south-central and southeastern Oregon have large areas of relatively unfragmented sage-dominated landscapes which are important for maintaining long-term connectivity between the sage-grouse populations (Knick and Hanser, in press, pp. 1-2.). Historically, central Oregon's population provided connectivity with the Columbia Basin area through narrow habitat corridors (Connelly *et al.* 2004, p. 6-13). These connections have now been lost, resulting in the isolation of the northern extant population in Washington. The Northern Great Basin ranks lowest of the MZs in the intensity of the human footprint and consequent

effects (Leu and Hanser, in press, p. 25; Wisdom *et al.*, in press, p. 16), and this could be contributing to the substantial connectivity that still exists between the Northern Great Basin, Snake River Plain, and the Southern Great Basin Region populations (Knick and Hanser, in press, p. 1). The BLM is the major land manager in this part of the southeastern Oregon, with jurisdiction over 49,000 km^2 (18,900 mi^2) (BLM 2009d, entire) that include much of the scantily vegetated ridge tops prone to high and sustained wind. At this time, most of the development activity is in the initial phase of meteorological site investigation and involves little infrastructure (AWEA 2009, entire; BLM 2009e). Many of these monitoring sites could be developed, considering the projected demand for renewable energy, contributing to fragmentation of this relatively intact sagebrush landscape.

Most published reports of the effects of wind development on birds focus on the risks of collision with towers or turbine blades. No published research is specific to the effects of wind farms on the greater sage-grouse. However, the avoidance of human-made structures such as powerlines and roads by sage-grouse and other prairie grouse is documented (Holloran 2005, p. 1; Pruett *et al*, in press, p. 6). Renewable energy facilities, including wind power, typically require many of the same features for construction and operation as do nonrenewable energy resources. Therefore, we anticipate that potential impacts from direct habitat losses, habitat fragmentation through roads and powerlines, noise, and increased human presence (Connelly *et al.* 2004, pp. 7-40 to 7-41) will generally be similar to those already discussed for nonrenewable energy development.

Wind farm development begins with site monitoring and collection of meteorological data to accurately characterize the wind regime. Turbines are installed after the meteorological data indicate the appropriate siting and spacing. Roads are necessary to access the turbine sites for installation and maintenance. Each turbine unit has an estimated footprint of 0.4 to 1.2 ha (1 to 3 ac) (BLM 2005a, pp. 3.1-3.4). One or more substations may be constructed depending on the size of the farm. Substation footprints are 2 ha (5 ac) or less in size (BLM 2005a, p. 3.7).

The average footprint of a turbine unit is relatively small from a landscape perspective. Turbines require careful placement within a field to avoid loss of output from interference with neighboring turbines. Spacing improves efficiency but expands the overall footprint of the field. Sage-grouse populations are impacted by the direct loss of habitat, primarily from construction of access roads as well as indirect loss of habitat due to avoidance. Sage-grouse could be killed by flying into turbine rotors or towers (Erickson *et al.* 2001, entire) although reported collision mortalities have been few. One sage-grouse was found dead within 45 m (148 ft) of a turbine on the Foote Creek Rim wind facility in south-central Wyoming, presumably from flying into a turbine (Young *et al.* 2003, Appendix C, p. 61). This is the only known sage-grouse mortality at this facility during three years of monitoring. Sage-grouse hens with broods have been observed under turbines at Foote Creek Rim (Young 2004, pers. comm.). We have no recent reports of sage-grouse mortality due to collision with a wind turbine; however, many facilities may not be monitored. No deaths of gallinaceous birds were reported in a comprehensive review of avian collisions and wind farms in the United States; the authors hypothesized that the average tower height and flight height of grouse, and diurnal migration habitats of some birds minimized the risk of collision (Johnson *et al.* 2000, pp. ii-iii; Erickson *et al.* 2001, pp. 8, 11, 14, 15).

Noise is produced by wind turbine mechanical operation (gear boxes, cooling fans) and airfoil interaction with the atmosphere. No published studies have focused specifically on the effects of wind power noise and greater sage-grouse. In studies conducted in oil and gas fields, noise may have played a factor in habitat selection and decrease in lek attendance (Holloran 2005, pp. 49, 56). However, comparison between wind turbine and oil and gas operations is difficult based on the character of sound. Adjusting for manufacturer type and atmospheric conditions, the audible operating sound of a single wind turbine has been calculated as the same level as conversational speech at 1 m (3 ft) at a distance of 600 m (2,000 ft) from the turbine. This level is typical of background levels of a rural environment (BLM 2005a, p. 5-24). However, commercial wind farms do not have a single turbine, and multiple turbines over a large area would likely have a much larger noise print. Low-frequency vibrations created by rotating blades produce annoyance responses in humans (van den Berg 2003, p. 1), but the specific effect on birds is not documented.

Moving blades of turbines cast moving shadows that cause a flickering effect producing a phenomenon called ''shadow flicker'' (AWEA 2008, p. 5-33). Hypothetically, shadow flicker could mimic predator shadows and elicit an avoidance response in birds during daylight hours, but this potential effect has not been investigated.

Since 2005, states have required an increasing amount of energy to come from renewable sources. For example, Colorado law requires incremental increases of renewable generation from 3 percent in 2007 to 20 percent by 2020 (AFWA and Service 2007, p. 8). Financial incentives, including grants and tax breaks, encourage private development of renewable sources. Although development of renewables is encouraged at a State level, siting authority for wind varies from State to State (AFWA and Service 2007, pp. 7, 8, 14, 28, 30, 36, 39, 43, 46, 49, 52; State of Oregon 2008, entire). For example, the State of Idaho provides tax incentives and loan programs for renewable energy development, but wind power is currently unregulated at any level of government (AFWA and Service 2007, p. 14). The North Dakota Public Service Commission regulates siting of wind power facilities over 100 megawatts using the Service's interim voluntary guidelines (Service 2003, entire).

Wyoming does not have a requirement for increased reliance on renewable energy sources and no specific wind siting authority. However, large construction projects in the State are subject to approval by an Industrial Siting Council (ISC) of the State Department of Environmental Quality, with the WGFD providing recommendations for mitigating impacts to wildlife associated with development considered by the ISC. The ISC's review and approval of projects is subject to the Wyoming Governor's executive order (State of Wyoming 2008, entire) that is intended to prevent harmful effects to sage-grouse from development or new land uses in designated core areas. Wind developers in Wyoming understand that most proposed wind developments regardless of locale must be approved by the ISC and that development proposed in core areas is unlikely to be permitted by the ISC due to the Governor's Executive Order (see discussion in Factor D below).

The BLM manages more land areas of high wind resource potential than any other land management agency. In 2005, the BLM completed the Wind Energy Final Programmatic EIS that provides an overarching guidance for wind project development on BLM-administered lands (BLM 2005a, entire). Best management practices (BMPs) are prescribed to minimize impacts of all phases of construction and operation of a wind production facility. The BMPs guide future project planning and do not

guarantee protections specific to sage-grouse. We do not have information on how or where the EIS guidance has been applied since 2005 and cannot evaluate its effectiveness. The footprint of wind energy developments is reported to be small (BLM 2005a, p. 5-2). The BLM indicates that approximately 600 km² (232 mi²) of BLM-administered lands are likely to be developed in nine States within the sage-grouse's range before 2025 (BLM 2005a, pp. ES-8, 5-2). It is estimated that only 5 to 10 percent of a development will have a long-term disturbance that remains on the landscape for at least as long as the generating facility is viable (i.e., roads, foundations, substation, fencing) (BLM 2005a, p. 5-2). However, this estimate does not account for sage-grouse avoidance of developed areas and could be an underestimation of indirect effects. Based on what we know of oil and gas development (previously described), the impact of structures, noise and human activity can reach far beyond the point of origin and contribute cumulatively to other human-made and natural disturbances that fragment and decrease the quality of sage-grouse habitats. The BLM's determination of the quantity of lands potentially impacted by wind energy development could be extremely conservative considering the interest in reducing green-house emissions and the institution of State renewable energy mandates and incentives that have occurred since 2005.

Wind development is guided by policy at BLM national and State levels that generally offers only guidance to avoid impacts to sage-grouse and habitats. A 2008 BLM Instruction Memo IM 2009-43 (BLM 2008e, p. 2) emphasizes the use of the Service's 2003 interim guidelines as voluntary and to be used only on a general basis in siting, design, and monitoring decisions. The BLM's Oregon State Office Instruction Memorandum OR-2008-014 (BLM 2007d, entire) is explicit in the placement of meteorological test towers to avoid active leks, seasonal concentrations, and collision; IM OR-2009-038 (BLM 2009f, entire) reduces the ODFW's recommended buffer distance for wind farms and applies only guidelines for avoidance of sage-grouse leks and seasonal habitats.

Wind energy resources are found throughout the range of the greater sage-grouse, and growth of wind power development is expected to continue. The DOE predicts that wind may provide a significant portion of the nation's energy needs by the year 2030, and substantial growth of wind developments will be required (DOE 2008, p. 1). In mid-2009, wind energy production facilities in the sage-grouse range in operation or under construction had a capacity of 11.93 gigawatts (AWEA 2009, entire) (Table 9). To achieve predicted levels of 49 to greater than 90 gigawatts capacity (DOE 2008, p. 10), the generation capacity will need to increase by 400 to 800 percent by 2030. Existing commercial wind turbines range from 1-2 megawatt generating capacity (AWEA 2009, entire). The forecasted increase in production would require approximately 37,000 to 78,000 or more turbines based on the existing technology and equipment in use. Assuming a generation capacity of 5 megawatts per km² (0.4 mi²) density, Copeland *et al.* (2009, p. 1) estimated an additional 50,000 km² (19,305 mi²) of land in the sage-grouse range would be required to meet the predicted level of wind-generated electricity by 2030.

TABLE 9— WIND ENERGY DEVELOPMENT IN THE GREATER SAGE-GROUSE RANGE, 2009–2030.

STATE	MZ	Existing Capacity 2009* (gigawatts)	Forecasted Capacity in 2030 (gigawatts)**
North Dakota	I	1.2	1 to 5
South Dakota	I	0.31	5 to 10
Montana	I	0.17	5 to 10
Wyoming	I, II	1.3	10 plus
Utah	II, III, IV, VII	0.4	1 to 5
Idaho	IV	0.15	1 to 5
Nevada	III, IV, V	0	5 to 10
California	III, V	2.8	10 plus
Oregon	IV, V	2.2	5 to 10
Washington	VI	2.2	5 to 10
Colorado	II, VII	1.2	1 to 5
Total		11.93	49 to 90 plus

*Includes completed and under construction, Source: American Wind Energy Assn. (2009, entire).
** Source: DOE (2008, p. 10).
(1000 megawatt = 1 gigawatt)

States such as Nevada and Montana that have not been tapped for extensive wind power development are likely to experience significant new energy development within the next 20 years (Table 9). In Wyoming, where wind development is advancing and predicted to increase by 10 fold or more (Table 9), the effects of both conventional and nonconventional renewable sources may claim a substantial toll on sage-grouse habitats and geographic areas that were in the past considered refugia for the species. As with oil and gas development, the average footprint of a turbine unit is relatively small from a landscape perspective, but the effects of large-scale developments have the potential to reduce the size of sagebrush habitats directly, degrade habitats with invasive

species, provide pathways for synanthropic predators (i.e., predators that live near and benefit from an association with humans), and cumulatively contribute to habitat fragmentation.

Other Renewable Energy Sources

Hydropower development can cause direct habitat losses and possibly an increase in human recreational activity. Reservoirs created concurrently with power generation structures inundated large areas of riparian habitats used by sage-grouse broods (Braun 1998, p. 144). Reservoirs and the availability of irrigation water precipitated conversion of large expanses of upland shrub-steppe habitat in the Columbia Basin adjacent to the rivers (65 FR 51578, August 24, 2000). We were unable to find any information regarding the amount of sage-grouse habitat affected by hydropower projects in other areas of the species' range beyond the Columbia Basin. No new large-scale facilities have been constructed and hydropower electricity generation has decreased steadily over the past 10 years (EIA 2009d, entire). We do not anticipate that future dam construction will result in large losses of sagebrush habitats.

Solar-powered electricity generation is increasing. Between 2005 and the end of 2008, solar electricity generation increased from the equivalent of 66 trillion Btu to 83 trillion Btu (EIA 2009d, entire). Solar-generating systems have been used on a small scale to power individual buildings, small complexes, remote facilities, and signs. Solar energy infrastructure is often ancillary to other development, and large-scale solar-generating systems have not contributed to any calculable direct habitat loss for sage-grouse, but this may change as more systems come on line for commercial electricity generation. Solar energy systems require, depending on local conditions, 1.6 ha (4 ac) to produce 1 megawatt of electricity. For example, the 162-ha (400-ac) Nevada Solar One, the third largest solar electricity producer in the world, has a maximum potential of 75 megawatts from a 121-ha (300-ac) solar field (nevadasolarone.com 2008, entire).

No commercial solar plants are operating in sage-grouse habitats at this time. Southern and eastern Nevada, the Pinedale area of Wyoming, and east-central Utah are the areas of the sage-grouse range with good potential for commercial solar development (EIA 2009e, entire). There are a total of 196 ha (484 ac) of active solar leases on BLM property in northern California (MZ IV) and central Wyoming (MZ II) (BLM 2009g, map) in sagebrush habitats within the current sage-grouse range and these leases will likely be developed. The BLM is developing a programmatic EIS for leasing and development of solar energy on BLM lands. The EIS planning period has been extended to analyze the effects of concentrating large-scale development in selected geographic areas including sage-grouse habitats in east-central Nevada and southern Utah (BLM 2009h, entire) because of the considerable administrative and public interest in developing public lands for solar-generated electricity (BLM 2009i, entire). At this time, we do not have enough information available to evaluate the scale of future impacts of solar power generation in sage-grouse habitats. We will continue to evaluate and monitor the impacts of solar power development in sage-grouse habitats as more information becomes available. We are not aware of any investigations reporting the impacts of solar generating facilities on sage-grouse or other gallinaceous birds. Commercial solar generation could produce direct habitat loss (i.e., solar fields completely eliminate habitat), fragmentation, roads, powerlines, increased human presence, and disturbance during facility construction with similar effects to sage-grouse as reported with oil and gas development.

Geothermal energy production has remained steady since 2005 (EIA 2009d, entire). Geothermal facilities are within the sage-grouse range in California (3 plants, MZ III), Nevada (5 plants, MZs III and V), Utah (2 plants, MZ III), and Idaho (1 plant, MZ IV). Since 2005, two additional plants were constructed is in current sage-grouse range – one in Idaho and one in Utah (Geothermal Energy Association 2008, pp. 2-7). One existing geothermal plant in southern Utah is in the vicinity of sage-grouse habitat in an area where wind power is being considered for development (First Wind-Milford 2009, entire), which will result in cumulative impacts. Geothermal potential occurs across the sage-grouse range in States with existing development and southeast Oregon, west-central Wyoming, and north-central Colorado (EIA 2009e, entire).

Geothermal energy production is similar to oil and gas development such that it requires surface exploration, exploratory drilling, field development, and plant construction and operation. Wells are drilled to access the thermal source and could take from 3 weeks to 2 months of continuous drilling (Suter 1978, p. 3), which may cause disturbance to sage-grouse. The ultimate number of wells, and therefore potential loss of habitat, depends on the thermal output of the well and expected production of the plant (Suter 1978, p. 3). Pipelines are needed to carry steam or superheated liquids to the generating plant which is similar in size to a coal- or gas-fired plant, resulting in further habitat and indirect disturbance. Direct habitat loss occurs from well pads, structures, roads, pipelines and transmission lines, and impacts would be similar to those described previously for oil and gas development.

The development of geothermal energy requires intensive human activity during field development and operation. Geothermal plants could be in remote areas necessitating housing construction, transportation, and utility infrastructure for employees and their families (Suter 1978, p. 12). Geothermal development could cause toxic gas release; the type and effect of these gases depends on the geological formation in which drilling occurs (Suter 1978, pp. 7-9). The amount of water necessary for drilling and condenser cooling may be high. Local water depletions may be a concern if such depletions result in the loss of brood-rearing habitat.

The BLM has the authority to lease geothermal resources in 11 western States. A programmatic EIS for geothermal leasing and operations was completed in 2008 (BLM and USFS 2008a, entire). Best management practices for minimizing the effects of geothermal development and operations on sage-grouse are guidance only and are general in nature (BLM and USFS 2008a, pp. 4.82-4.83). The EIS' reasonably foreseeable development scenario predicts that Nevada will experience the greatest increase in geothermal growth–doubling the production of electricity from geothermal sources by 2025 (BLM and USFS 2008, p. 2-35). Currently, approximately 1,800 km^2 (694 mi^2) of active geothermal leases exist on public lands primarily in the Southern (MZ IV) and Northern Great Basin (MZ III) and 1,138 km^2 (439 mi^2) of leases are pending (Knick *et al.*, in press, p. 138).

Energy production from biomass sources has increased every year since 2005 (EIA 2009d, entire). Wood has been a primary biomass source, but corn ethanol and biofuels produced from cultivated crops are on the increase (EIA 2008b, entire). Currently, wood products and corn production do not occur in the range of the sage-grouse in significant quantities (Curtis 2008, p. 7). The National Renewable Energy Laboratory cites potentials for agricultural biomass resources in northern Montana (MZ I), southern Idaho (MZ IV), eastern Washington (MZ

VI), eastern Oregon MZ IV), northwest Nevada (MZ V), and southeast Wyoming (MZ II) (NREL 2005, entire). Conversion from native sod to agriculture for the purpose of biomass production could result in a loss of sage-grouse habitat on private lands. The 2007 Energy Independence and Security Act mandated incremental production and use through the year 2022 of advanced biofuel, cellulosic biofuel, and biomass-based diesel (P.L. 110-140, section 203) and could provide an incentive to convert native sod or expired CRP lands to biomass crops. The effects on sage-grouse will depend on amount and location of sagebrush habitats developed. The effects of agriculture are discussed in habitat conversion section above.

Transmission Corridors

Section 368(a) of the Energy Policy Act of 2005 (42 U.S.C. 15926) directs Federal land management agencies to designate corridors on Federal land in 11 western States for oil, gas and hydrogen pipelines and electricity transmission and distribution facilities (energy transport corridors). The agencies completed a programmatic EIS (DOE *et al.* 2008, entire) to address the environmental impacts of corridors on Federal lands. The proposed action calls for designating more than 9,600 km (6,000 mi) with an average width of 1 km (0.6 mi) of energy corridors across the western United States (DOE *et al.* 2008, p. S-17). The designated corridors on Federal lands will tie in to corridors on private lands and lands in other governmental jurisdictions. Some of the areas proposed for designation are currently used for transmission. Federal lands newly incorporated into transportation or utility rights-of-way are mostly BLM lands in California (185 km, 115 mi), Colorado (97 km, 60 mi), Idaho (303 km, 188 mi), Montana (254 km, 158 mi), Nevada (810 km, 503 mi), Oregon (418 km, 260 mi), Washington (no additional land), Utah (356 km, 221 mi), and Wyoming (198 km, 123 mi) (DOE *et al.* 2008, p. S-18).

It is uncertain how much of the proposed corridors are in sagebrush habitat within the distribution area of sage-grouse, but based on the proposed location, habitat in Wyoming (MZ II), Idaho (MZ IV), Utah (MZ III), Nevada (MZ III) and Oregon (MZs III and IV) would be most affected. The purpose of the corridor designation is to serve a role in expediting applications to construct or modify oil, gas, and hydrogen pipelines and electricity transmission and distribution. These designated areas will likely facilitate the development of novel renewable and nonrenewable electricity generating facilities on public and private lands. Sage-grouse could be impacted through a direct loss of habitat, human activity (especially during construction periods), increased predation, habitat deterioration through the introduction of nonnative plant species, and additional fragmentation of habitat.

Summary: Energy Development

Energy development is a significant risk to the greater sage-grouse in the eastern portion of its range (Montana, Wyoming, Colorado, and northeastern Utah – MZs I, II, VII and the northeastern part of MZ III), with the primary concern being the direct effects of energy development on the long-term viability of greater sage-grouse by eliminating habitat, leks, and whole populations and fragmenting some of the last remaining large expanses of habitat necessary for the species' persistence. The intensity of energy development is cyclic and based on many factors including energy demand, market prices, and geopolitical uncertainties. However, continued exploration and development of traditional and nonconventional fossil fuel sources in the eastern portion of the greater sage-grouse range is predicted to continue to increase over the next 20 years (EIA 2009b, p. 109). Greater sage-grouse populations are predicted to decline 7 to 19 percent over the next 20 years due to the effects of oil and gas development in the eastern part of the range (Copeland *et al.* 2009, p. 4); this decline is in addition to the 45 to 80 percent decline that is estimated to have already occurred range wide (Copeland *et al.* 2009, p. 4).

Development of commercially viable renewable energy—wind, solar, geothermal, biomass—is increasing across the range with focus in some areas already experiencing traditional energy development (EIA 2009b, pp. 3-4; AWEA 2009a, entire). In Wyoming, where wind development is advancing and predicted to increase by 10-fold (DOE 2008, p. 10), the effects of both conventional and nonconventional and renewable sources may claim a substantial toll on sage-grouse habitats and geographic areas that were in the past considered refugia for the species. Renewable energy resources are likely to be developed in areas previously untouched by traditional energy development. Wind energy resources are being investigated in south-central and southeastern Oregon where large areas of relatively unfragmented sage-dominated landscapes are important for maintaining long-term connectivity within the sage-grouse populations (Knick and Hanser in press, pp. 1-2.).

Greater sage-grouse populations are negatively affected by energy development activities, even when mitigative measures are implemented (Holloran 2005, pp. 57-60; Walker *et al.* 2007a, p. 2651). Energy development, particularly high density development, will continue to threaten sage-grouse populations, specifically in the MZs I and II, which contain the greatest numbers of birds throughout their range.

Development of commercially viable renewable energy–wind, solar, geothermal, biomass–is rapidly increasing rangewide with a focus in some areas already experiencing significant traditional energy development (e.g., MZs I and II). The effects of renewable energy development are likely similar to those of nonrenewable energy as similar types of infrastructure are required. Based on our review of the literature, we anticipate the impacts of these developments will negatively affect the ability of greater sage-grouse to persist in those areas in the foreseeable future.

Climate Change

The Intergovernmental Panel on Climate Change (IPCC) has concluded that warming of the climate is unequivocal, and that continued greenhouse gas emissions at or above current rates will cause further warming (IPCC 2007, p. 30). Eleven of the 12 years from 1995 through 2006 rank among the 12 warmest years in the instrumental record of global surface temperature since 1850 (ISAB 2007). Climate-change scenarios estimate that the mean air temperature could increase by over 3°C (5.4°F) by 2100 (IPCC 2007, p. 46). The IPCC also projects that there will very likely be regional increases in the frequency of hot extremes, heat waves, and heavy precipitation (IPCC 2007, p. 46), as well as increases in atmospheric carbon dioxide (IPCC 2007, p. 36).

We recognize that there are scientific differences of opinion on many aspects of climate change, including the role of natural variability in climate. In our analysis, we rely primarily on synthesis documents (e.g., IPCC 2007; Global Climate Change Impacts in the United States 2009) that present the consensus view of a very large number of experts on climate change from around the world. We have found that these synthesis reports, as well as the scientific papers used in those reports or resulting from those reports, represent the best available scientific information we can use to inform our decision and have relied upon them and provided

citation within our analysis. In addition, where possible we have used projections specific to the region of interest, the western United States and southern Canada, which includes the range of the greater sage-grouse. We also use projections of the effects of climate change to sagebrush where appropriate, while acknowledging that the uncertainty of climate change effects increases as one applies those potential effects to a habitat variable like sagebrush, and then increases again when the impacts to the habitat variable are applied to the species.

Projected climate change and its associated consequences have the potential to affect greater sage-grouse and may increase its risk of extinction, as the impacts of climate change interact with other stressors such as disease, and habitat degradation and loss that are already affecting the species (Walker and Naugle, in press, entire; Global Climate Change Impacts in the United States 2009, p. 81; Miller *et al.* in press, pp. 46-50). In the Pacific Northwest, regionally averaged temperatures have risen 0.8 degrees Celsius (1.5 degrees Fahrenheit) over the last century (as much as 2 degrees Celsius (4 degrees Fahrenheit) in some areas), and are projected to increase by another 1.5 to 5.5 degrees Celsius (3 to 10 degrees Fahrenheit) over the next 100 years (Mote *et al.* 2003, p. 54; Global Climate Change Impacts in the United States 2009, p. 135). Arid regions such as the Great Basin where greater sage-grouse occurs are likely to become hotter and drier; fire frequency is expected to accelerate, and fires may become larger and more severe (Brown *et al.* 2004, pp. 382-383; Neilson *et al.* 2005, p. 150; Chambers and Pellant 2008, p. 31; Global Climate Change Impacts in the United States 2009, p. 83).

Climate changes such as shifts in timing and amount of precipitation, and changes in seasonal high and low temperatures, as well as average temperatures, may alter distributions of individual species and ecosystems significantly (Bachelet *et al.* 2001, p174). Under projected future temperature conditions, the cover of sagebrush within the distribution of sage-grouse is anticipated to be reduced (Neilson *et al.* 2005, p. 154; Miller *et al.* in press, p. 45). Warmer temperatures and greater concentrations of atmospheric carbon dioxide create conditions favorable to *Bromus tectorum*, as described above, thus continuing the positive feedback cycle between the invasive annual grass and fire frequency that poses a significant threat to greater sage-grouse (Chambers and Pellant 2008, p. 32; Global Climate Change Impacts in the United States 2009, p. 83). Fewer frost-free days also may favor frost-sensitive woodland vegetation of Sonoran and Chihuahuan deserts, which may expand, potentially encroaching on the sagebrush biome in the southern Great Basin where sage-grouse populations currently exist (Miller *et al.* in press, p. 44). Such encroachment of woody vegetation degrades sage-grouse habitat (see Factor A, Invasive plants).

Temperature and precipitation both directly influence potential for West Nile virus (WNv) transmission (Walker and Naugle in press, p. 12). In sage-grouse, WNv outbreaks appear to be most severe in years with higher summer temperatures (Walker and Naugle in press, p. 13) and under drought conditions (Epstein and Defilippo, p. 105). This relationship is due to the breeding cycle of the WNv vector, *Culex tarsalis* being highly dependent on warm water temperature for mosquito activity and virus amplification (Walker and Naugle in press, p. 12; see discussion under Disease and Predation below). Therefore, the higher summer temperatures and more frequent or severe drought or both, that are likely under current climate change projections, make more severe WNv outbreaks likely in low-elevation sage-grouse habitats where WNv is already endemic, and also make WNv outbreaks possible in higher elevation sage-grouse habitats that to date have been WNv-free due to relatively cold conditions.

Emissions of carbon dioxide, considered to be the most important anthropogenic greenhouse gas, increased by approximately 80 percent between 1970 and 2004 due to human activities (IPCC 2007, p. 36). Future carbon dioxide emissions from energy use are projected to increase by 40 to 110 percent over the next few decades, between 2000 and 2030 (IPCC 2007, p. 44). An increase in the atmospheric concentration of carbon dioxide has important implications for greater sage-grouse, beyond those associated with warming temperatures, because higher concentrations of carbon dioxide are favorable for the growth and productivity of *Bromus tectorum* (Smith *et al.* 1987, p. 142; Smith *et al.* 2000, p. 81). Although most plants respond positively to increased carbon dioxide levels, many invasive nonnative plants respond with greater growth rates than native plants, including *B. tectorum* (Smith *et al.* 1987, p. 142; Smith *et al.* 2000, p. 81; Global Climate Change Impacts in the United States 2009, p. 83). Laboratory research results illustrated that *B. tectorum* grown at carbon dioxide levels representative of current climatic conditions matured more quickly, produced more seed and greater biomass, and produced significantly more heat per unit biomass when burned than *B. tectorum* grown at ''pre-industrial'' carbon dioxide levels (Blank *et al.* 2006, pp. 231, 234). These responses to increasing carbon dioxide may have increased the flammability in *B. tectorum* communities during the past century (Ziska *et al.* 2005, as cited in Zouhar *et al.* 2008, p. 30; Blank *et al.* 2006, p. 234).

Field studies likewise demonstrate that *Bromus* species demonstrate significantly higher plant density, biomass, and seed rain (dispersed seeds) at elevated carbon dioxide levels relative to native annuals (Smith *et al.* 2000, pp. 79-81). The researchers conclude that ''the results from this study confirm experimentally in an intact ecosystem that elevated carbon dioxide may enhance the invasive success of *Bromus* spp. in arid ecosystems,'' and suggest that this enhanced success will then expose these areas to accelerated fire cycles (Smith *et al.* 2000, p. 81). Chambers and Pellant (2008, p. 32) also suggest that higher carbon dioxide levels are likely increasing *B. tectorum* fuel loads due to increased productivity, with a resulting increase in fire frequency and extent. Based on the best available information, we expect the current and predicted atmospheric carbon dioxide levels to increase the threat posed to greater sage-grouse by *B. tectorum* and from more frequent, expansive, both in sage-grouse habitat degradation (functional fragmentation) and severe wildfires (Smith *et al.* 1987, p. 143; Smith *et al.* 2000, p. 81; Brown *et al.* 2004, p. 384; Neilson *et al.* 2005, pp. 150, 156; Chambers and Pellant 2008, pp. 31-32). Therefore, beyond the potential changes associated with temperature and precipitation, increases in carbon dioxide concentrations represent a threat to the sagebrush biome and an indirect threat to sage-grouse through habitat degradation and loss (Miller *et al.* in press, p. 45), with the combined effects of higher temperatures and carbon dioxide concentrations leading to a loss of 12 percent of the current area of sagebrush per degree Celsius of temperature increase, or from 34 to 80 percent of sagebrush distribution depending on the emissions scenario used (Nielson *et al.* 2005, p. 6, 10; Miller *et al.* in press, p. 45).

Bradley (2009, pp. 196-208) and Bradley *et al.* (2009, pp. 1-11) predict that nonnative invasive species in the sagebrush-steppe ecosystem may either expand or contract under climate

change, depending on the current and projected future range of a particular invasive plant species. They developed a bioclimatic model for *B. tectorum* based on maps of invaded range derived from remote sensing. The best predictors of *B. tectorum* occurrence were summer, annual, and spring precipitation, followed by winter temperature (Bradley *et al.*, 2009, p. 5). Depending primarily on future precipitation conditions, the model predicts *B. tectorum* is likely to shift northwards, leading to expanded risk of *B. tectorum* invasion in Idaho, Montana, and Wyoming, but reduced risk of invasion in southern Nevada and Utah, which currently have large areas dominated by this nonnative grass (Bradley *et al.*, 2009, p. 5). Therefore, the threat posed to greater sage-grouse by the greater frequency and geographic extent of wildfires and other associated negative impacts from the presence of *B. tectorum* is expected to continue into the foreseeable future. Bradley (2009, pp. 205) stated that the bioclimatic model she used is an initial step in assessing the potential geographic extent of *B. tectorum*, because climate conditions only affect invasion on the broadest regional scale. Other factors relating to land use, soils, competition, or topography may affect suitability of a given location. Bradley (2009, entire) concludes that the potential for climate to shift away from suitability for *B. tectorum* in the future may offer an opportunity for restoration of the sagebrush biome in this area. We anticipate that areas that become unsuitable for *B. tectorum*, may transition to other vegetation over time. However, it is not known if transition back to sagebrush as a dominant landcover or to other native or nonnative vegetation is more likely.

In a study that modeled potential impacts to big sagebrush (*A. tridentata* ssp.) due to climate change, Shafer *et al.* (2001, pp. 200-215) used response surfaces to describe the relationship between bioclimatic variables and the distribution of tree and shrub taxa in western North America. Species distributions were simulated using scenarios generated by three general circulation models – HADCM2, CGCM1, and CSIRO. Each scenario produced similar results, simulating future bioclimatic conditions that would reduce the size of the overall range of sagebrush and change where sagebrush may occur. These simulated changes were the result of increases in the mean temperature of the coldest month which the authors speculated may interact with soil moisture levels to produce the simulated impact. Each model predicted that climate suitability for big sagebrush would shift north into Canada. Areas in the current range would become less suitable climatically, and would potentially cause significant contraction. The authors also point out that increases in fire frequency under the simulated climate projections would leave big sagebrush more vulnerable to fire impacts.

Shafer *et al.* (2001, pp. 213) explicitly state that their approach should not be used to predict the future range of a species, and that the underlying assumptions of the models they used are ''unsatisfying'' because they presume a direct causal relationship between the distribution of a species and particular environmental variables. Shafer *et al.* (2001, pp. 207, 213) identify cautions similar to Bradley *et al.* (in press, pp. 205) regarding their models. A variety of factors are not included in climate space models, including: the effect of elevated CO2 on the species' water-use efficiency, what really is the physiological effect of exceeding the assumed (modeled) bioclimatic limit on the species, the life stage at which the limit affects the species (seedling versus adult), the life span of the species, and the movement of other organisms into the species range (Shafer *et al.*, 2001, pp. 207). These variables would likely help determine how climate change would affect species distributions. Shafer *et al.* (2001, pp. 213) concludes that while more empirical studies are needed on what determines a species and multi-species distributions, those data are often lacking; in their absence climatic space models can play an important role in characterizing the types of changes that may occur so that the potential impacts on natural systems can be assessed.

Schrag *et al.* (submitted MS, 2009, pp. 1-42) developed a bioclimatic envelope model for big sagebrush and silver sagebrush in the States of Montana, Wyoming, and North and South Dakotas. This analysis suggests that large displacement and reduction of sagebrush habitats will occur under climate change as early as 2030 for both species of sagebrush examined. At the time of this finding, the Schrag *et al.* analysis has not been peer reviewed, and we have significant reservations about using analyses of this level of complexity in making management decisions, without it having gone through a review process where experts in the fields of climate change, bioclimatic modeling, and sagebrush ecology can all assess the validity of the reported results. Other models projecting the affect of climate change on sagebrush habitat discussed more below, identify uncertainty associated with projecting climatic habitat conditions into the future given the unknown influence of other factors that such models do not incorporate (e.g., local physiographic conditions, life stage of the plant, generation time of the plant and its reaction to changing CO2 levels).

In some cases, effects of climate change can be demonstrated (e.g., McLaughlin *et al.* 2002) and where it can be, we rely on that empirical evidence, such as increased stream temperatures (see Rio Grande cutthroat trout, 73 FR 27900), or loss of sea ice (see polar bear, 73 FR 28212), and treat it as a threat that can be analyzed. However, we have no such data relating to greater sage-grouse. Application of continental scale climate change models to regional landscapes, and even more local or ''step-down'' models projecting habitat potential based on climatic factors, while informative, contain a high level of uncertainty due to a variety of factors including: regional weather patterns, local physiographic conditions, life stages of individual species, generation time of species, and species reactions to changing CO2 levels. The models summarized above are limited by these types of factors; therefore, their usefulness in assessing the threat of climate change on greater sage-grouse also is limited.

Summary: Climate Change

The direct, long-term impact from climate change to greater sage-grouse is yet to be determined. However, as described above, the invasion of *Bromus tectorum* and the associated changes in fire regime currently pose one of the significant threats to greater sage-grouse and the sagebrush-steppe ecosystem. Under current climate-change projections, we anticipate that future climatic conditions will favor further invasion by *B. tectorum,* as well as woody invasive species that affect habitat suitability, and that fire frequency will continue to increase, and the extent and severity of fires may increase as well. Climate warming is also likely to increase the severity of WNv outbreaks and to expand the area susceptible to outbreaks into areas that are now too cold for the WNv vector. Therefore, the consequences of climate change, if current projections are realized, are likely to exacerbate the existing primary threats to greater sage-grouse of frequent wildfire and invasive nonnative plants, particularly *B. tectorum* as well as the threat posed by disease. As the IPCC projects that the changes to the global climate system in

the 21st century will likely be greater than those observed in the 20th century (IPCC 2007, p. 45), we anticipate that these effects will continue and likely increase into the foreseeable future. As there is some degree of uncertainty regarding the potential effects of climate change on greater sage-grouse specifically, climate change in and of itself was not considered a significant factor in our determination whether greater sage-grouse is warranted for listing. However, we expect the severity and scope of two of the significant threats to greater sage-grouse, frequent wildfire and *B. tectorum* colonization and establishment; as well as epidemic WNv, to magnify within the foreseeable future due the effects of climate change already underway (i.e., increased temperature and carbon dioxide). Thus, currently we consider climate change as playing a potentially important indirect role in intensifying some of the current significant threats to the species.

Analysis of Habitat Fragmentation in the Context of Factor A

Greater sage-grouse are a landscape-scale species requiring large, contiguous areas of sagebrush for long-term persistence. Large-scale characteristics within surrounding landscapes influence habitat selection, and adult sage-grouse exhibit a high fidelity to all seasonal habitats, resulting in little adaptability to changes. Fragmentation of sagebrush habitats has been cited as a primary cause of the decline of sage-grouse populations (Patterson 1952, pp. 192-193; Connelly and Braun 1997, p. 4; Braun 1998, p. 140; Johnson and Braun 1999, p. 78; Connelly *et al.* 2000a, p. 975; Miller and Eddleman 2000, p. 1; Schroeder and Baydack 2001, p. 29; Johnsgard 2002, p. 108; Aldridge and Brigham 2003, p. 25; Beck *et al.* 2003, p. 203; Pedersen *et al.* 2003, pp. 23-24; Connelly *et al.* 2004, p. 4-15; Schroeder *et al.* 2004, p. 368; Leu *et al.* in press, p. 19). Documented negative effects of fragmentation include reduced lek persistence, lek attendance, population recruitment, yearling and adult annual survival, female nest site selection, nest initiation, and loss of leks and winter habitat (Holloran 2005, p. 49; Aldridge and Boyce 2007, pp. 517-523; Walker *et al.* 2007a, pp. 2651-2652; Doherty *et al.* 2008, p. 194). Functional habitat loss also contributes to habitat fragmentation as greater sage-grouse avoid areas due to human activities, including noise, even though sagebrush remains intact. In an analysis of population connectivity, Knick and Hanser (in press, p. 31) demonstrated that in some areas of the sage-grouse range, populations are already isolated and at risk for extirpation due to genetic, demographic, and environmental stochasticity. Habitat loss and fragmentation contribute to this population isolation and increased risk of extirpation.

We examined several factors that result in habitat loss and fragmentation. Historically, large losses of sagebrush habitats occurred due to conversion for agricultural croplands. This conversion is continuing today, and may increase due to the promotion of biofuel production and new technologies to provide irrigation to arid lands. Indirect effects of agricultural activities, such as linear corridors created by irrigation ditches, also contribute to habitat fragmentation by allowing the incursion of nonnative plants. Direct habitat loss and fragmentation also has occurred as the result of expanding human populations in the western United States, and the resulting urban development in sagebrush habitats.

Fire is one of the primary factors linked to population declines of greater sage-grouse because of long-term loss of sagebrush and conversion to nonnative grasses. Loss of sagebrush habitat to wildfire has been increasing in the western portion of the greater sage-grouse range due to an increase in fire frequency and size. This change is the result of incursion of nonnative annual grasses, primarily *Bromus tectorum*, into sagebrush ecosystems. The positive feedback loop between *B. tectorum* and fires facilitates future fires and precludes the opportunity for sagebrush, which is killed by fire, to become re-established. *B. tectorum* and other invasive plants also alter habitat suitability for sage-grouse by reducing or eliminating native forbs and grasses essential for food and cover. Annual grasses and noxious perennials continue to expand their range, facilitated by ground disturbances, including wildfire, grazing, agriculture, and infrastructure associated with energy development and urbanization. Concern with habitat loss and fragmentation due to fire and invasive plants has mostly been focused in the western portion of the species' range. However, climate change may alter the range of invasive plants, potentially expanding this threat into other areas of the species' range. The establishment of these plants will then contribute to increased fire frequency in those areas, further compounding habitat loss and fragmentation. Functional habitat loss is occurring from the expansion of native conifers, mainly due to decreased fire return intervals, livestock grazing, increases in global carbon dioxide concentrations, and climate change.

Sage-grouse populations are significantly reduced, including local extirpation, by nonrenewable energy development activities, even when mitigative measures are implemented (Walker *et al.* 2007a, p. 2651). The persistent and increasing demand for energy resources is resulting in their continued development within sage-grouse range, and will only act to increase habitat fragmentation. Habitat fragmentation due to energy development results not only from the actual footprint of energy development and its appurtenant facilities (e.g., powerlines, roads), but also from functional habitat loss (e.g., noise, presence of overhead structures).

Livestock management and domestic livestock and wild horse grazing have the potential to seriously degrade sage-grouse habitat at local scales through loss of nesting cover, decreasing native vegetation, and successional stage and, therefore, vegetative resiliency, and increasing the probability of incursion of invasive plants. Fencing constructed to manage domestic livestock causes direct mortality, degradation, and fragmentation of habitats, and increased predator populations. There is little direct evidence linking grazing practices to population levels of greater sage-grouse. However, testing for impacts of grazing at landscape scales important to sage-grouse is confounded by the fact that almost all sage-grouse habitat has at one time been grazed, and thus no non-grazed areas currently exist with which to compare. While some rangeland treatments to remove sagebrush for livestock forage production can temporarily increase sage-grouse foraging areas, the predominant effect is habitat loss and fragmentation, although those losses cannot be quantified or spatially analyzed due to lack of data collection.

Restoration of sagebrush habitat is challenging, and restoring habitat function may not be possible because alteration of vegetation, nutrient cycles, topsoil, and cryptobiotic crusts have exceeded recovery thresholds. Even if possible, restoration will require decades and will be cost-prohibitive. To provide habitat for sage-grouse, restoration must include all seasonal habitats and occur on a large scale (4,047 ha (10,000 ac) or more) to provide all necessary habitat components. Restoration may never be achieved in the presence of invasive grass species.

The WAFWA identified a goal of ''no net loss'' of birds and habitat in their Greater Sage-grouse Comprehensive Conservation Strategy (Stiver *et al.* 2006, p. 1-7). Knick and Hanser (in press, p. 32) have concluded that this

strategy may no longer be possible due to natural and anthropogenic threats that are degrading the remaining sagebrush habitats. They recommend focusing conservation on areas critical to range-wide persistence of this species (Knick and Hanser in press, p. 31). Wisdom *et al.* (in press, pp. 24-25) and Knick and Hanser (in press, p. 17) identified two strongholds of contiguous sagebrush habitat essential for the long-term persistence of greater sage-grouse (the southwest Wyoming Basin and the Great Basin area straddling the States of Oregon, Nevada, and Idaho). Other areas within the greater sage-grouse range had a high uncertainty for continued population persistence (Wisdom *et al.*, in press, p. 25) due to fragmentation from anthropogenic impacts. However, our analyses of fragmentation in the two stronghold areas showed that habitats in these areas are becoming fragmented due to wildfire, invasive species, and energy development. Therefore, we are concerned that the level of fragmentation in these areas may already be limiting sage-grouse populations and further reducing connectivity between populations. These threats have intensified over the last two decades, and we anticipate that they will continue to accelerate due to the positive feedback loop between fire and invasives and the persistent and increasing demand for energy resources.

Population Trends in Relation to Habitat Loss and Fragmentation

In order to assess the effects of habitat loss and fragmentation on greater sage-grouse populations and persistence, we examined a variety of data to understand how population trends reflected the changing habitat condition. Patterns of sage-grouse extirpation were identified by Aldridge *et al.* 2008 (entire) Johnson *et al.* (in press, entire), Wisdom *et al.* (in press, entire), Knick and Hanser (in press, entire), and others, and discussed in detail above. Examples include fragmentation of populations and their isolation as a result of habitat loss from fire (Knick and Hanser in press, p. 20; Wisdom *et al.* in press, p. 22), an increase in the probability of extirpation as a result of fire (Knick and Hanser in press, p. 31) and agricultural activities and human densities (Aldridge *et al.* 2008, p. 990; Wisdom *et al.* in press, p. 4), and sage-grouse population declines as a result of energy development (Doherty *et al.* 2008, p. 193; Johnson *et al.* in press, p. 13; Leu and Hanser, in press, p. 28). Therefore, where these habitat factors, and others identified above, are occurring, we anticipate that sage-grouse population trends will continue to decline.

Lek count data are the only data available to estimate sage-grouse population trends, and are the data WAFWA collects (WAFWA 2008, p. 3). The use of lek count data as an index of trends involves various types of uncertainty (such as measurement error, count methods, statistical and other types of assumptions; e.g. see Connelly *et al.*, 2004, pp. 6-18 to 6-20; and WAFWA 2008, pp. 7-8). Nevertheless, these data have been collected for 50 years in most locations and therefore do have utility in examining long-term trends (Gerrodette 1987, p. 1370; Connelly *et al.* 2004, p. A3-3; Stiver *et al.* 2009, p. 3-5; WAFWA 2008, p. 3), and in evaluating differences in trends across the species' range. Therefore, we are considering the results of researchers whose work relies on lek data (e.g., Garton *et al.* (in press), Wisdom *et al.* (in press), Connelly *et al.* (2004, p. 6-18 to 6-59; WAFWA 2008, entire) to help inform our overall analyses.

Population trends (average number of males per lek) in MZs I and II, the areas with the highest concentration of nonrenewable energy development, decreased by 17 and 30 percent from 1965 to 2007, respectively (Garton *et al.* in press, pp. 28, 35). Individual population trends within each MZ varied. However, in areas of intensive energy development, trends were negative as habitat continued to be fragmented. For example, in the Powder River Basin of Wyoming, sage-grouse populations have declined by 79 percent in the 12 years since coal-bed methane development was initiated there (Emmerich 2009, pers. comm.). In MZs affected by *Bromus tectorum* and fire, (primarily MZs IV (Snake River Plain) and V (Northern Great Basin)), population trends from 1995 to 2007 also were negative (Table 6). These results are consistent with the analyses conducted by Wisdom *et al.* (in press, p. 24) that demonstrate that fragmentation as a result of disturbance results in reduced population numbers and population isolation.

In some populations within the species' range, population trends (number of males counted on leks) since the early 1990s appear to be stable, and in some cases increasing (Garton *et al.* in press, Figs.2-8, pp.188-219). However, simply looking at total number of males counted does not accurately reflect habitat conditions, as leks, and by inference the associated breeding habitats, could have been lost. Additionally, as discussed above, sage-grouse will continue to attend leks even after habitat suitability is diminished simply due to site fidelity (Walker *et al.* 2007a, p. 2651). Therefore, the counts of males on these leks may artificially minimize the declines seen in trend analyses, as little productivity results from them. Because the analyses were truncated in 2007 to be comparable to other analyses of population trends (i.e. Connelly *et al.* 2004 and WAFWA 2008, see discussion under population size above), delays in population response to habitat loss and fragmentation events within the past 2 to 3 years may not have been captured. Also, some significant events that have resulted in habitat loss occurred after the 2007 lekking season. For example, the Murphy complex fire in Idaho and Nevada burned 264,260 ha (653,000 ac), resulting in the loss of 75 of 102 leks, and the associated nesting habitats in the area. Population-level effects of this fire would not be reflected by any of the three population trend analyses (Connelly *et al.*, 2004; WAFWA 2008; Garton *et al.* in press) simply because it occurred after the time period analyzed.

Projections of Future Populations

As described above, our analysis of habitat trends, and those provided in the published literature show that population extirpation and declines have, and are likely to continue to track habitat loss or environmental changes (e.g., Walker *et al.*, 2005, Aldridge *et al.* 2008; Knick and Hanser in press; Wisdom *et al.* in press). Estimation of how these trends may affect future population numbers and habitat carrying capacity was conducted by Garton *et al.* (in press, entire). We realize population viability analyses are based on assumptions that may or may not be realistic given the species analyzed. Additionally, lek counts are not the best data for use in these kinds of analyses as variability in lek attendance, observer bias, and the unknown relationship between males counted to actual population sizes limit unbiased estimation of future population numbers (see also discussion under population sizes above, and in Garton *et al.*, in press, pp. 8, 66). At the request of the Colorado Division of Wildlife, three individuals (Conroy 2009, entire; Noon 2009, entire; Runge 2009, entire) reviewed Garton *et al.* outside the established peer review process and noted similar limitations of these data. We received these reviews and have reviewed them in the context of all other data we received in preparation of this finding. Their primary concern was about the applicability of analyzing and presenting future population projections in the manner done by Garton *et al.* in press, based on the limitations of the

data, the assumptions required, and uncertainty in the estimates of the model parameters (see also discussion above).

Garton *et al.*, (in press, pp. 6-8, 64-67) acknowledged these concerns, as several of the reviewers pointed out, and their analyses underwent peer review via the normal scientific process prior to acceptance for publication. Population viability analyses can provide useful information in examining the potential future status of a species as long as the assumptions of the model, and violations thereof, are clearly identified and considered in the interpretation of the results. Therefore, we present the analyses conducted by Garton *et al.* (in press, entire) here in relation to our conclusion of how existing and continued habitat fragmentation may impact the greater sage-grouse within the foreseeable future. The projections reported by Garton *et al.* (in press, entire; see discussion below) are generally consistent with what we expect given the causes of sage-grouse declines and extirpation documented in the literature (see above) and where those threats occur in the species range, despite the concerns of the authors and others about the limitations of lek data and prospective analysis. We are unaware of any other prospective rangewide population viability analyses for this species.

Garton *et al.* (in press, entire) projected population and habitat carrying capacity trends (the modeled estimate where population growth rate is 0) at 30 (2037) and 100 (2107) years into the future. Growth rates were analogous to rates from 1987 to 2007, and quasi-extinction thresholds (artificial thresholds below which the long-term persistence and viability of a species is questionable due to stochastic variables, such as small populations or genetic inbreeding) corresponded to minimum counts of 20 and 200 males at leks (Garton *et al.* in press, p. 19). The thresholds were established to correspond to populations of 50 and 500 breeding birds, numbers generally accepted for adequate effective population sizes to avoid negative genetic effects from inbreeding (Garton *et al.* in press, p. 19). Therefore, population projections that fell below 50 breeding adults (males and females) were identified as being at short-term risk of extinction, and those that fell below 500 breeding adults (males and females) were identified as being at long-term risk for extinction. However, recent work by Bush (2009, p. 106) suggests that a higher proportion of male sage-grouse are breeding than previously identified. Therefore, Garton *et al.* (in press, p. 20) state that their resulting projections are likely underestimates of actual impacts as more birds are necessary than they assumed for population productivity. Additionally, Traill *et al.* (2010, p. 32) argue that a minimum effective population size must be 5,000 individuals to maintain evolutionary minimal viable populations of wildlife (retention of sufficient genetic material to avoid effect of inbreeding depression or deleterious mutations). We examined the projected population trends for 30 years to minimize the risk of error associated with the 100 year projections simply due to using lek data.

One assumption made by Garton *et al.* (in press, p. 19) is that future population growth would be analogous to what occurred from 1987 to 2007. We anticipate adverse habitat impacts (see discussion of foreseeable future below) and synergism between these impacts (e.g. fire and invasive species expansion) to increase habitat loss; therefore, Garton *et al.*'s (in press) likely over-estimate the resulting future habitat carrying capacity and population numbers.

In all MZs, the analyses by Garton *et al.* (in press) predict that populations will continue to decline. In MZ I, Garton *et al.* (in press, p. 29) project a population decline of 59 percent between 2007 and 2037 if current population and habitat trends continue (Table 10). In the Powder River Basin area, where significant gas development is occurring, population trends were projected an almost 90 percent decline by 2037 (Garton *et al.* in press, p. 26). This projection is consistent with Walker *et al.* (2007, p. 2651) estimate that lek persistence would decline to 5 percent in the Powder River Basin with full field development over a similar time frame. Also, Johnson (in press, p. 13) found that lek counts were reduced from 1997 to 2007 in areas of oil and gas development, and our GIS analyses found that a minimum of 70 percent of breeding habitats is affected by energy development activities in this area (Service 2008b; see discussion under Energy Development). Declines in the Powder River Basin within the past 12 years of development have reached 79 percent (Emmerich 2009, pers. comm.). Populations in MZ I that do not experience the same levels of energy development are not projected to decline as significantly, with the exception of the Yellowstone watershed population (Table 10). This population is projected to be extirpated within 30 years (Garton *et al.* in press, p. 46). This area is highly fragmented by agricultural and energy development, factors identified by Aldridge *et al.* (2008, p. 991) and Wisdom *et al.* (in press, p. 23) with sage-grouse extirpation. Wisdom *et al.* (in *press*, p. 23) also predicted extirpation in this area due to the continuing loss of sagebrush. Loss of the Yellowstone watershed population will result in a gap in the species' range, isolating sage-grouse north of the Missouri River from the rest of the species.

TABLE 10—PROJECTED CHANGES IN CARRYING CAPACITIES OF MANAGEMENT ZONES AND POPULATIONS FROM 2007 TO 2037. CARRYING CAPACITIES ARE REFLECTED AS THE AVERAGE NUMBER OF MALES PER LEK, AND WERE CALCULATED BY DIVIDING POPULATION PROJECTIONS FOR 2037 BY THE POPULATION ESTIMATE IN 2007. DATA FROM GARTON *et al.* (IN PRESS, PP. 22-63, 95-97).

Management Zone	Population	Change in Carrying Capacity from 2007 to 2037 (%)
I (Great Plains)		-59
	Yellowstone watershed	-100
	Powder River	-90
	Northern Montana	-11
	Dakotas	-62

TABLE 10—PROJECTED CHANGES IN CARRYING CAPACITIES OF MANAGEMENT ZONES AND POPULATIONS FROM 2007 TO 2037. CARRYING CAPACITIES ARE REFLECTED AS THE AVERAGE NUMBER OF MALES PER LEK, AND WERE CALCULATED BY DIVIDING POPULATION PROJECTIONS FOR 2037 BY THE POPULATION ESTIMATE IN 2007. DATA FROM GARTON *et al*. (IN PRESS, PP. 22-63, 95-97).—Continued

Management Zone	Population	Change in Carrying Capacity from 2007 to 2037 (%)
II (Wyoming Basin)		-66
	Eagle – S. Routt	extirpated
	Jackson Hole	—
	Middle Park	—
	Wyoming Basin	-64
III (Southern Great Basin)		-55
	Bi-State NV/CA	-7
	S. Mono Lake	—
	NE Interior UT	+211
	San Pete County UT	—
	S. central UT	-36
	Summit-Morgan UT	-14
	Toole-Juab UT	-27
	Southern Great Basin	-61
IV (Snake River Plain)		-55
	Baker, OR	No change
	Bannack, MT	-9
	Red Rocks, MT	-18
	Wisdom, MT	—
	E. central ID	—
	Snake, Salmon, Beaverhead, ID	-18
	Northern Great Basin	-73
V (Northern Great Basin)		-74
	Central OR	-67
	Klamath, OR	—
	NW Interior NV	—
	Western Great Basin	-59
VI (Columbia Basin)		-46
	Moses Coulee	-74
	Yakima	—

TABLE 10—PROJECTED CHANGES IN CARRYING CAPACITIES OF MANAGEMENT ZONES AND POPULATIONS FROM 2007 TO 2037. CARRYING CAPACITIES ARE REFLECTED AS THE AVERAGE NUMBER OF MALES PER LEK, AND WERE CALCULATED BY DIVIDING POPULATION PROJECTIONS FOR 2037 BY THE POPULATION ESTIMATE IN 2007. DATA FROM GARTON *et al.* (IN PRESS, PP. 22-63, 95-97).—Continued

Management Zone	Population	Change in Carrying Capacity from 2007 to 2037 (%)
VII (Colorado Plateau)*		—

— Data insufficient to model
* Although the model projects population increases, habitat is limited in the area, likely limiting actual population growth.

Garton *et al.* (in press, p. 36) projected populations will decline in MZ II by 66 percent between 2007 and 2037 if current population trends and habitat activities continue (Table 10). The Wyoming Basin area, where significant oil, gas and renewable energy development is occurring, is projected to decline by 64 percent (Garton *et al.* in press, p. 34). Population persistence for the Eagle–South Routt population, an area also experiencing significant energy development activities, could not be estimated due to data sampling concerns. However, the population is unlikely to persist for 20 years (Braun, as cited in Garton *et al.* in press, p 30), where 100 percent of the breeding habitat is affected by energy development (Service 2008b). Johnson (in press, p. 13) found that declines in lek attendance was strongly, negatively associated with the presence of wells in these areas once the total number of wells in this MZ exceeded 250. Wells in both of these populations currently exceed that threshold. Therefore, the results of Garton *et al.*'s (in press) analyses are not unexpected.

Garton *et al.* (in press, p. 46) projected populations in MZ III will decline by 53 percent between 2007 and 2037 if current population trends and habitat activities continue (Table 10). Most populations in this area are already isolated by topographic features and experience high native conifer incursions. *Bromus tectorum* also is of significant concern in the Southern Great Basin population. Large losses of sagebrush in this MZ have resulted from *B. tectorum* incursion and the resulting altered fire cycle (Johnson in press, p. 23). Fire within 54 km (33.5 mi) of a lek was identified by Knick and Hanser (in press, p. 29) as one of the most important factors negatively affecting sage-grouse persistence on the landscape. Assuming the current rate of habitat loss continues in this MZ, carrying capacity is projected to decline by 45 percent by 2037 (Garton *et al.* in press, p. 46).

In MZ IV, Garton *et al.* (in press, p. 53) populations are projected to decline by 55 percent between 2007 and 2037 if current population trends and habitat activities continue (Table 10). The Northern Great Basin population is projected to have the greatest drop in carrying capacity, and is the area currently most affected by reduced fire cycles as a result of *Bromus tectorum* incursions. As discussed above, fire within 54 km (33.5 mi) of a lek was identified by as one of the most important factors negatively affecting sage-grouse persistence on the landscape (Knick and Hanser in press, p. 29). The associated incursion of *B. tectorum* has resulted in large losses of habitat in this MZ (Johnson in press, p. 23). Carrying capacities in other populations in this MZ are not projected to decline as much, but these populations do not have significant fire and *B. tectorum* incursions.

In MZ V, Garton *et al.* (in press, p. 58) projected populations will decline by 74 percent between 2007 and 2037 if current population trends and habitat activities continue (Table 10). Nearly all populations within this MZ are affected by reduced fire frequencies and *Bromus tectorum* incursions (see discussion above). In MZ VI, Garton *et al.* (in press, p. 62) projected populations will decline by 46 percent between 2007 and 2037 if current population trends and habitat activities continue (Table 10). The two populations in this MZ are already isolated from the rest of the range, and actively managed by the State of Washington to maintain birds (e.g., translocations, active habitat enhancement). In addition to impacts from agricultural activities and human development (Johnson in press, p. 27), these populations are affected by the loss of CRP lands and military activities, neither of which were quantified by Garton *et al.* (in press, entire). Therefore, the projections provided in the population viability analysis are likely underestimated.

Carrying capacity projections could not be estimated for MZ VII due to insufficient data. Energy development activities occur within most populations in this area, and Johnson (in press, p. 13) reported that lek attendance was lower around producing wells in this MZ. We believe that based on habitat impacts, if birds are retained in this area, the populations will be reduced in size and further isolated.

The projections from Garton *et al.* (in press, entire), which are consistent with results reported by Wisdom *et al.* (in press, entire), our own analyses, and others examining the effects of habitat loss and degradation on population trends, reflect that by 2037 sage-grouse populations and connectivity between them will be further reduced across the species range. This is consistent with other literature that has documented patterns of decline and extirpation as a result of the ongoing habitat losses and fragmentation (for example, see Johnson in press, Knick *et al.* in press and Wisdom *et al.* in press). We are cautious in using a single projection for determining future population status based on the limitation of lek data and the lack of any other comparable rangewide population viability analyses. However, Garton *et al.*'s (in press, entire) results are consistent with the habitat loss and fragmentation analyses conducted by the Service and many other authors, as noted in the individual MZ discussions above.

The population and carrying capacity projections by Garton *et al.* (in press, pp. 22-64) are generally consistent with what we would expect given the causes of sage-grouse declines and extirpation documented in the literature (see above) and where those threats occur in the species range. Therefore, despite the concerns of the authors and other about the limitations of lek data and prospective analysis, the results presented by Garton *et al.* (in press, entire) are consistent with our analyses of habitat impacts based on the review of the best available scientific information.

Foreseeable Future of Habitat Threats

We examined the persistence of each of these habitat threats on the landscape to help inform a determination of foreseeable future. Habitat conversion and fragmentation resulting from agricultural activities and urbanization will continue indefinitely. Human populations are increasing in the western United States and we have no data indicating this trend will be reversed. Increased fire frequency as facilitated by the expanding distribution of invasive plant species will continue indefinitely unless an effective means for controlling the invasives is found. In the last approximately 100 years, no broad scale *Bromus tectorum* eradication method has been developed. Therefore, given the history of invasive plants on the landscape, our continued inability to control such species, and the expansive infestation of invasive plants across the species' range currently, we anticipate they and associated fires will be on the landscape for the next 100 years or longer.

Continued exploration and development of traditional and nonconventional fossil fuel sources in the eastern portion of the greater sage-grouse range will continue to increase over the next 20 years (EIA 2009b, p. 109). Based on existing National Environmental Policy Act (NEPA) documents for major oil and gas developments, production within existing developments will continue for a minimum of 20 years, with subsequent restoration (if possible) requiring from 30 to 50 additional years. Renewable energy development is estimated to reach maximum development by 2030. However, since most renewable energy facilities are permanent landscape features, unlike oil, gas and coal, direct and functional habitat loss from the development footprint will be permanent. Based on this information, we estimate the foreseeable future of energy development at a minimum of 50 years, and perhaps much longer for nonrenewable sources.

Grazing (both domestic and wild horse and burro) is unlikely to be removed from sagebrush ecosystems. Therefore, it is difficult to estimate a foreseeable future for livestock grazing. However, as of 2007, there were 7,118,989 permitted AUMs in sage-grouse habitat. Although there have been recent reductions in the number of AUMs (3.4 percent since 2005), we have no information suggesting that livestock grazing will be significantly reduced, or removed, from sage-grouse habitats. Therefore, while we cannot provide an exact estimate of the foreseeable future for grazing, we expect it to be a persistent use of the sage-grouse landscape for several decades.

Summary of Factor A

As identified above in our Factor A analysis, habitat conversion for agriculture, urbanization, infrastructure (e.g., roads, powerlines, fences); fire, invasive plants, pinyon-juniper woodland encroachment, grazing, energy development, and climate change are all contributing, individually and collectively, to the present and threatened destruction, modification, and curtailment of the habitat and range of the greater sage-grouse. The impacts are compounded by the fragmented nature of this habitat loss, as fragmentation results in functional loss of habitat for greater sage-grouse even when otherwise suitable habitat is still present.

Fragmentation of sagebrush habitats is a key cause, if not the primary cause, of the decline of sage-grouse populations. Fragmentation can make otherwise suitable habitat either too small or isolated to be of use to greater sage-grouse (i.e., functional habitat destruction), or the abundance of sage-grouse that can be supported in an area is diminished. Fire, invasive plants, energy development, various types of infrastructure, and agricultural conversion have resulted in habitat fragmentation and additional fragmentation is expected to continue for the foreseeable future in some areas.

In our evaluation of Factor A, we found that although many of the habitat impacts we analyzed (e.g, fire, urbanization, invasive species) are present throughout the range, they are not at a level that is causing a threat to greater sage-grouse everywhere within its range. Some threats are of high intensity in some areas but are low or nonexistent in other areas. Fire and invasive plants, and the interaction between them, is more pervasive in the western part of the range than in the eastern. Oil and gas development is having a high impact on habitat in many areas in the eastern part of the range, but a low impact further to the west. The impact of pinyon-juniper encroachment generally is greater in western areas of the range, but is of less concern in more eastern areas such as Wyoming and Montana. Agricultural development is high in the Columbia Basin, Snake River Plain, and eastern Montana, but low elsewhere. Infrastructure of various types is present throughout the most of range of the greater sage-grouse, as is livestock grazing, but the degree of impact varies depending on grazing management practices and local ecological conditions. The degree of urbanization and exurban development varies across the range, with some areas having relatively low impact to habitat.

While sage-grouse habitat has been lost or altered in many portions of the species' range, habitat still remains to support the species in many areas of its range (Connelly *et al.* in press c, p. 23), such as higher elevation sagebrush, and areas with a low human footprint (activities sustaining human development) such as the Northern and Southern Great Basin (Leu and Hanser in press, p. 14), indicating that the threat of destruction, modification or curtailment of the greater sage-grouse is moderate in these areas. In addition, two strongholds of contiguous sagebrush habitat (the southwest Wyoming Basin and the Great Basin area straddling the States of Oregon, Nevada, and Idaho) contain the highest densities of males in the range of the species (Wisdom *et al.* in press, pp. 24-25; Knick and Hanser in press, p. 17). We believe that the ability of these strongholds to maintain high densities to date in the presence of several threats indicates that there are sufficient habitats currently to support the greater sage-grouse in these areas, but not throughout its entire range unless these threats are ameliorated.

As stated above, the impacts to habitat are not uniform across the range; some areas have experienced less habitat loss than others, and some areas are at relatively lower risk than others for future habitat destruction or modification. Nevertheless, the impacts are substantial in many areas and will continue or even increase in the future across much of the range of the species. With continued habitat destruction and modification, resulting in fragmentation and diminished connectivity, greater sage-grouse populations will likely decline in size and become more isolated, making them more vulnerable to further reduction over time and increasing the risk of extinction.

We have evaluated the best scientific and commercial information available regarding the present or threatened destruction, modification, or curtailment of the greater sage-grouse's habitat or range. Based on the current and ongoing habitat issues identified here, their synergistic effects, and their likely continuation in the future, we conclude that this threat is significant such that it provides a basis for determining that the species warrants listing under the Act as a threatened or endangered species.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.

Commercial Hunting

The greater sage-grouse was heavily exploited by commercial hunting in the late 1800s and early 1900s (Patterson 1952, pp. 30-32; Autenrieth 1981, pp. 3-11). Hornaday (1916, pp. 179-221) and others alerted the public to the risk of extinction of the species as a result of this overharvest. The impacts of hunting on greater sage-grouse during those historical decades may have been exacerbated by impacts from human expansion into sagebrush-steppe habitats (Girard 1937, p. 1). In response, many States closed sage-grouse hunting seasons by the 1930s (Patterson 1952, pp.30-33; Autenrieth 1981, p. 10). Sage-grouse have not been commercially harvested for many decades; therefore, commercial hunting does not affect the greater sage-grouse.

Recreational Hunting

With the increase of sage-grouse populations by the 1950s, limited recreational hunting seasons were allowed in most of the species' range (Patterson 1952, p. 242; Autenrieth 1981, p.11). Currently, greater sage-grouse are legally sport-hunted in 10 of 11 States where they occur (Connelly *et al.* 2004, p. 6-3). The hunting season for sage-grouse in Washington was closed in 1988, and the species was added to the State's list of threatened species in 1998 (Stinson *et al.* 2004, p. 1). In Canada, sage-grouse are designated as an endangered species, and hunting is not permitted (Connelly *et al.* 2004, p. 6-3).

[INSERT FIGURE 3 GRAPH HERE]

Harvest levels have varied considerably since the 1950s, and in recent years have been much lower than in past decades (Figure 3) (Service 2009, unpublished data). From 1960 to 1980, the majority of sage-grouse hunting mortality occurred in Wyoming, Idaho, and Montana, accounting for at least 75 to 85 percent of the annual harvest (Service 2009, unpublished data). In the 1960s harvest exceeded 120,000 individuals annually for 7 out of 10 years. Harvest levels reached a maximum in the 1970s, being above 200,000 individuals in 9 of 10 years with the total estimate at 2,322,581 birds harvested for the decade. During the 1980s, harvest exceeded 130,000 individuals in 9 of 10 years (Service 2009, unpublished data). The harvest was above 100,000 annually during the early 1990s but in 1994 dropped below 100,000 for the first time in decades. From 2000 to 2007, annual harvest has averaged approximately 31,000 birds (Service 2009, unpublished data).

Sustainable harvest is determined based on the concept of compensatory and additive mortality (Connelly 2005, p. 7). The compensatory mortality hypothesis asserts that if sage-grouse produce more offspring than can survive to sexual maturity, individuals lost to hunting represent losses that would have occurred otherwise from some other source (e.g., starvation, predation, disease). Hunting mortality is termed additive if it exceeds natural mortality and ultimately results in a decline of the breeding population. The validity of compensatory mortality in upland gamebirds has not been rigorously tested, and as we stated above, annual sage-grouse productivity is relatively low compared to other grouse species. Autenrieth (1981, p. 77) suggested sage-grouse could sustain harvest rates of up to 30 percent annually. Braun (1987, p. 139) suggested a rate of 20 to 25 percent was sustainable. State wildlife agencies currently attempt to keep harvest levels below 5 to 10 percent of the population, based on a recommendation taken from Connelly *et al.* (2000a, p. 976). However, it is unclear from Connelly *et al.* (2000a) what this recommendation is based on, and similar to previous suggested harvest rates, it has not been experimentally tested with regard to its impacts on sage-grouse populations.

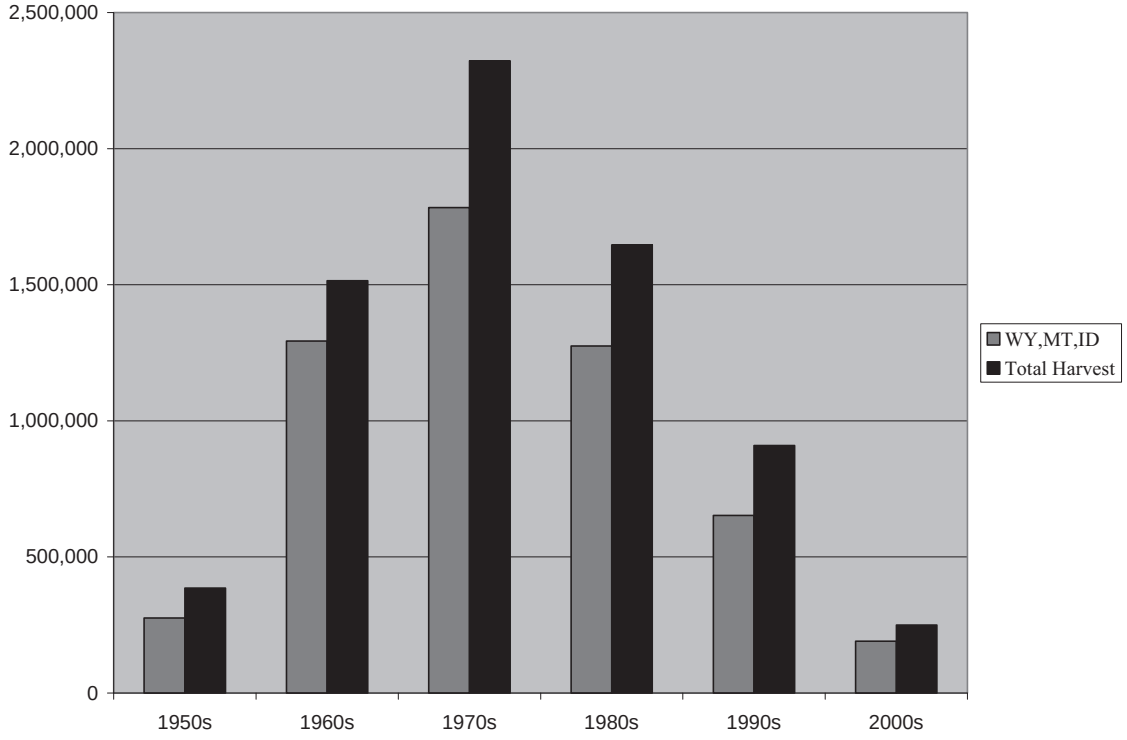
The validity of the idea that hunting is a form of compensatory mortality for upland game birds has been questioned in recent years (Reese and Connelly, in press, p. 6). Connelly *et al.* 2005 (pp. 660, 663) cite many studies suggesting that hunting of upland game, including the greater sage-grouse, is often not compensatory. Other studies have sought to determine whether hunting mortality in sage-grouse is compensatory or additive (Crawford 1982; Crawford and Lutz 1985; Braun 1987; Zunino 1987; Johnson and Braun 1999; Connelly *et al.* 2003; Sedinger *et al.* in press; Sedinger *et al.* unpublished data). Results of those studies have been contradictory. For example, Braun (1987, p. 139) found that harvest levels of 7 to 11 percent had no effect on subsequent spring breeding populations based on lek counts in North Park, Colorado. Johnson and Braun (1999, p. 83) determined that overwinter mortality correlated with harvest intensity in North Park, Colorado, and hypothesized that hunting mortalities may be additive.

Numerous contradictions are likely due to differing methods, lack of experimental data, and differing effects of harvest due to a relationship between harvest and habitat quality. For example, Connelly *et al.* (2003, pp. 256-257) evaluated data for monitored lek routes in areas experiencing different levels of harvest (no harvest, 1-bird season, 2-bird season) in Idaho and found that populations with no hunting season had faster rates of population increase than populations with a light to modest harvest. The effect was particularly pronounced in xeric habitats near human populations, which suggests that the impact of hunting on sage-grouse to some extent depends on habitat quality. Gibson (1998, p. 15) found that hunting mortality had negative impacts on the population dynamics of an isolated population of sage-grouse in Long Valley, California, but appeared to have no effect on sage-grouse in Bodie Hills, California, a nearby population that is contiguous with adjacent occupied areas of Nevada. Data indicated that hunting suppressed the population size of the isolated Long Valley population well below the apparent carrying capacity (Gibson 1998, p. 15; Gardner 2008, pers. comm.).

Sage-grouse hunting is regulated by State wildlife agencies. Hunting seasons are reviewed annually, and States change harvest management based on estimates for spring production and population size (e.g., Bohne 2003, pp.1-10). However, harvest affects fall populations of sage-grouse, and currently there is no reliable method for obtaining estimates of fall population size (Connelly *et al.* 2004, p. 9-6). Instead, lek counts conducted in the spring are used as a surrogate for fall population size. However, fall populations are already reduced from spring estimates as some natural mortality inevitably has occurred in the interim (Kokko 2001, p. 164). The discrepancy between spring and fall population size estimates plays a role in determining whether harvest will be within the recommended level of less than 5-10 percent of the fall population. For example, hen mortality in Montana increased from the typical level of 1 to 5 percent to 16 percent during July/August in a year (2003) with WNv mortality (Moynahan 2006, p.1535). During the summer of 2006 and 2007 in South Dakota, mortality from WNv was estimated to be between 21 and 63 percent of the population (Kaczor 2008, p.72). Despite the increased mortalities due to WNv, hunting regulations in both States remained similar to previous years.

Female survivorship is a key element of population productivity. Harvest might affect female and male grouse differently. Connelly *et al.* (2000b, p.228-229) found that in Idaho 42

Figure 3—Total greater sage-grouse harvest by decade for available State-wide harvest estimates. For illustrative purposes, harvest estimates are shown as totals and as a combination for WY, MT, and ID, the States with the greatest individual harvest levels. (Values are underestimates as no data were available for CA, CO, MT, and NV in the 1950s, and total harvest values for WY were not reported prior to 1957; no data were available in the 1960s for CA, ND, or SD, and data for NV and CO were only partially reported; and no data were available for CA and ND in the 1970s).



percent of all documented female mortality was attributable to hunting while for males the number was 15 percent. Patterson (1952, p. 245) found females accounted for 60 percent (1950) and 63 percent (1951) of total hunting mortalities. Because sage-grouse are relatively long-lived, have moderate reproductive rates, and are polygynous, their populations are likely to be especially sensitive to adult female survival (Schroeder 1999, p.2, 13; Saether and Bakke 2000, p. 652; Connelly 2005, p.9). Yearling sage-grouse hens have less reproductive potential than adults (Dalke *et al.* 1963, p. 839; Moynahan 2006, p. 1537). Adult females have higher nest initiation rates, higher nest success, and higher chick survival rates than yearling females (Connelly *et al.*, in press a, pp. 15, 20, 48). High adult female mortality has the potential to result in negative lag effects as future populations become overrepresented by yearling females (Moynahan 2006, p. 1537).

All States with hunting seasons have changed limits and season dates to more evenly distribute hunting mortality across the entire population structure of greater sage-grouse, harvesting birds after females have left their broods (Bohne 2003, p. 5). Females and broods congregate in mesic areas late in the summer potentially making them more vulnerable to hunting (Connelly *et al.* 2000b, p. 230). However, despite increasingly later hunting seasons, hens in Wyoming continue to comprise the majority of the harvest in all years (WGFD 2004a, p. 4; 2006, p. 7). From 1996 to 2008, on average 63 percent of adult hunting mortalities in Nevada were females (range 58 percent to 73 percent) (NDOW, 2009, unpublished data). In 2008 in Oregon, adult females accounted for 70 percent of the adults harvested (ODFW 2009). These results could indicate that females are more susceptible to hunting mortality, or it could be a reflection of a female skewed sex ratio in adult birds. Male sage-grouse typically have lower survival rates than females, and the varying degrees of female skewed sex ratios recorded for sage-grouse are thought to be as a result of this differential survival (Swenson 1986, p. 16; CO Conservation Plan, p. 54). The potential for negative effects on populations by harvesting reproductive females has long been recognized by upland game managers (e.g., hunting of female ring-necked pheasants, (*Phasianus colchicus),* is prohibited in most States).

Harvest management levels that are based on the concept of compensatory mortality assume that overwinter mortality is high, which is not true for sage-grouse (winter mortality rates approximately 2 percent, Connelly *et al.* 2000b, p. 229). Additionally, due to WNv, sage-grouse population dynamics may be increasingly affected by mortality that is density independent (i.e., mortality that is independent of population size). Further, there is growing concern regarding wide-spread habitat degradation and fragmentation from various sources, such as development, fire, and the spread of noxious weeds, resulting in density independent mortality which increases the probability that harvest mortality will be additive.

State management agencies have become increasingly responsive to these concerns. All of the States where hunting greater sage-grouse is legal, except Montana, now manage harvests on a regional scale rather than applying State-wide limits. Bag limits and season lengths are relatively conservative compared to prior decades (Connelly 2005, p. 9; Gardner 2008, pers. comm.). Emergency closures have been used for some declining populations. For example, North Dakota closed the 2008 and 2009 hunting seasons following record low lek attendance likely due to WNv (Robinson 2009, pers. comm.). Hunting on the Duck Valley Indian Reservation (Idaho/Nevada) has been closed since 2006 due to WNv (Dick 2009, pers. comm.; Gossett 2008, pers. comm.). Hunting in Owyhee County, Idaho was closed in 2006 and again in 2008 and 2009 as a result of WNv (Dick 2008, pers. comm.; IDFG 2009).

All ten States that allow bow and gun hunting of sage-grouse also allow falconers to hunt sage-grouse. Falconry seasons are typically longer (60 to 214 days), and in some cases have larger bag limits than bow/gun seasons. However, due to the low numbers of falconers and their dispersed activities, the resulting harvest is thought to be negligible (Apa 2008, pers. comm.; Northrup 2008, pers. comm.; Hemker 2008, pers. comm.; Olsen 2008, pers. comm.; Kanta 2008, pers. comm.). Wyoming is one of the few States that collects falconry harvest data and reported a take of 180 sage-grouse by falconers in the 2006-2007 season (WGFD 2007, unpublished data). In Oregon, the take is probably less than five birds per year (Budeau 2008, pers. comm.). In Idaho the 2005 estimated Statewide falconry harvest was 77 birds, and that number has likely remained relatively constant (Hemker 2008, pers. comm.). We are not aware of any studies that have examined falconry take of greater sage-grouse in relation to population trends, but the amount of greater sage-grouse mortality associated with falcon sport hunting appears to be negligible.

We surveyed the State fish and wildlife agencies within the range of greater sage-grouse to determine what information they had on illegal harvest (poaching) of the species. Nevada and Utah indicated they were aware of citations being issued for sage-grouse poaching, but that it was rare (Espinosa 2008, pers. comm.; Olsen 2008, pers. comm.). Sage-grouse wings are infrequently discovered in wing-barrel collection sites during forest grouse hunts in Washington, but such take is considered a result of hunter misidentification rather than deliberate poaching (Schroeder 2008, pers. comm.). None of the remaining States had any quantitative data on the level of poaching. Based on these results, illegal harvest of greater sage-grouse poaching appears to occur at low levels. We are not aware of any studies or other data that demonstrate that poaching has contributed to sage-grouse population declines.

Recreational Use

Greater sage-grouse are subject to a variety of non-consumptive recreational uses such as bird watching or tour groups visiting leks, general wildlife viewing, and photography. Daily human disturbances on sage-grouse leks could cause a reduction in mating and some reduction in total production (Call and Maser 1985, p. 19). Overall, a relatively small number of leks in each State receive regular viewing use by humans during the strutting season and most States report no known impacts from this use (Apa 2008, pers. comm.; Christiansen 2008, pers. comm.; Gardner 2008, pers. comm.; Northrup 2008, pers. comm.). Only Colorado has collected data regarding the effects of non-consumptive use. Their analyses suggest that controlled lek visitation has not impacted greater sage-grouse (Apa 2008, pers. comm.). However, Oregon reported anecdotal evidence of negative impacts of unregulated viewing to individual leks near urban areas that are subject to frequent disturbance from visitors (Hagen 2008, pers. comm.).

To reduce any potential impact of lek viewing on sage-grouse, several States have implemented measures to protect most leks while allowing recreational viewing to continue. The Wyoming Game and Fish Department (WGFD) provides the public with directions to 16 leks and guidelines to minimize viewing disturbance. Leks included in the brochure are close to roads and already subject to some level of disturbance (Christiansen 2008, pers. comm.); presumably, focusing attention

on these areas reduces pressure on relatively undisturbed leks. Colorado and Montana have some sites with viewing trailers for the public for the same reasons (Apa 2008, pers. comm.; Northrup 2008, pers. comm.). We were not able to locate any studies documenting how lek viewing, or other forms of non-consumptive recreational uses, of sage-grouse are related to sage-grouse population trends. Given the relatively small number of leks visited, we have no reason to believe that this type of recreational activity is having a negative impact on local populations or contributing to declining population trends.

Religious Use

Some Native American tribes harvest greater sage-grouse as part of their religious or ceremonial practices as well as for subsistence. Native American hunting occurs on the Wind River Indian Reservation (Wyoming), with about 20 males per year taken off of leks in the spring plus an average fall harvest of approximately 40 birds (Hnilicka 2008, pers. comm.). The Shoshone-Bannock Tribe (Idaho) occasionally takes small numbers of birds in the spring, but no harvest figures have been reported for 2007 and 2008 (Christopherson 2008, pers. comm.). The Shoshone-Paiute Tribe of the Duck Valley Indian Reservation (Idaho and Nevada) suspended hunting in 2006 to 2009 due to significant population declines resulting from a WNv outbreak in the area (Dick 2009, pers. comm.; Gossett 2008, pers. comm.). Prior to 2006, the sage-grouse hunting season on the Duck Valley Indian Reservation ran from July 1 to November 30 with no bag or possession limits. Preliminary estimates indicate that the harvest may have been as high as 25 percent of the population (Gossett 2008, pers. comm.). Despite the hunting ban, populations have not recovered on the reservation (Dick 2009, pers. comm.; Gossett 2008, pers. comm.). No harvest by Native Americans for subsistence or religious and ceremonial purposes occurs in South Dakota, North Dakota, Colorado, Washington, or Oregon (Apa 2008, pers. comm.; Hagen 2008, pers. comm.; Kanta 2008, pers. comm.; Robinson 2008, pers. comm.; Schroeder 2008, pers. comm.).

Scientific and Educational Use

Greater sage-grouse are the subject of many scientific research studies. We are aware of some 51 studies ongoing or completed during 2005 and 2008. Of the 11 western States where sage-grouse currently occur, all reported some type of field studies that included the capture, handling, and subsequent banding, or banding and radio-tagging of sage-grouse. In 2005, the overall mortality rate due to the capture, handling, and/or radio-tagging process was calculated at approximately 2.7 percent of the birds captured (68 mortalities of 2,491 captured). A survey of State agencies, BLM, consulting companies, and graduate students involved in sage-grouse research indicates that there has been little change in direct handling mortality since then. We are not aware of any studies that document that this level of taking has affected any sage-grouse population trends.

Greater sage-grouse have been translocated in several States and the Province of British Columbia (Reese and Connelly 1997, p. 235). Reese and Connelly (1997, pp. 235-238) documented the translocation of over 7,200 birds between 1933 and 1990. Only 5 percent of the translocation efforts documented by Reese and Connelly (1997, p. 240) were considered to be successful in producing sustained, resident populations at the translocation sites. From 2003 to 2005, 137 adult female sage-grouse were translocated to Strawberry Valley, Utah and had a 60 percent annual survival rate (Baxter *et al.* 2006, p. 182). Since 2004, Oregon and Nevada have supplied the State of Washington with close to 100 greater sage-grouse to increase the genetic diversity of the geographically isolated Columbia Basin populations and to reestablish a historical population. One bird has died during transit and as expected natural mortality for translocated birds has been higher than resident populations (Schroeder 2008, pers. comm.). Given the low numbers of birds that have been used for translocation spread over many decades, it is unlikely that the removals from source populations have contributed to greater sage-grouse declines, while the limited success of translocations also has likely had nominal impact on rangewide population trends. We did not find any information regarding the direct use of greater sage-grouse for educational purposes.

Summary of Factor B

Greater sage-grouse are not used for any commercial purpose. In Canada, hunting of sage-grouse is prohibited in Alberta and Saskatchewan. In the United States, sage-grouse hunting is regulated by State wildlife agencies and hunting regulations are reevaluated yearly. We have no information that suggests any change will occur in the current situation, in which hunting greater sage-grouse is prohibited in Washington and allowed elsewhere in the range of the species in the U.S. under State regulations, which provide a basis for adjustments in annual harvest and emergency closures of hunting seasons. We have no evidence suggesting that gun and bow sport hunting has been a primary cause of range-wide declines of the greater sage-grouse in the past, or that it currently is at level that poses a significant threat to the species. However, although harvest as a singular factor does not appear to threaten the species throughout its range, negative impacts on local populations have been demonstrated and there remains a large amount of uncertainty regarding harvest impacts because of a lack of experimental evidence and conflicting studies. Significant habitat loss and fragmentation have occurred during the past several decades, and there is evidence that the sustainability of harvest levels depends to a large extent upon the quality of habitat and the health of the population. However, recognition that habitat loss is a limiting factor is not conclusive evidence that hunting has played no role in population declines or that reducing or eliminating harvest will not have an effect on population stability or recovery.

Take from poaching (illegal hunting) appears to occur at low levels in localized areas, and there is no evidence that it contributes to population declines. The information on non-consumptive recreational activities is limited to lek viewing, the extent of such activity is small, and there is no indication that it has a negative impact that contributes to population declines. Harvest by Native American tribes, and mortality that results from handling greater sage-grouse for scientific purposes appears to occur at low levels in localized areas and thus we do not consider these to be a significant threat at either the rangewide or local population levels. We know of no utilization for educational purposes. We have no reason to believe any of the above activities will increase in the future.

We do not believe data support overuse of sage-grouse as a singular factor in rangewide population declines. We note, however, that in light of present and threatened habitat loss (Factor A) and other considerations (e.g. West Nile virus outbreaks in local populations), continued close attention will be needed by States and tribes to carefully manage hunting mortality, including adjusting seasons and allowable harvest levels, and imposing emergency closures if needed.

In sum, we find that this threat is not significant to the species such that it causes the species to warrant listing under the Act.

Factor C: Disease and Predation.

Disease

Greater sage-grouse are hosts for a variety parasites and diseases, including macroparasitic arthropods, helminths and microparasites (protozoa, bacteria, viruses and fungi) (Thorne *et al.* 1982, p. 338; Connelly *et al.* 2004, pp. 10-4 to 10-7; Christiansen and Tate, in press, p. 2). However, there have been few systematic surveys for parasites or infectious diseases of greater sage-grouse; therefore, whether they have a role in population declines is unknown (Connelly *et al.* 2004, p. 10-3; Christiansen and Tate, in press, p. 3). Early studies have suggested that sage-grouse populations are adversely affected by parasitic infections (Batterson and Morse 1948, p. 22). Parasites also have been implicated in sage-grouse mate selection, with potentially subsequent effects on the genetic diversity of this species (Boyce 1990, p. 263; Deibert 1995, p. 38). However, Connelly *et al.* (2004, p. 10-6) note that, while these relationships may be important to the long-term ecology of greater sage-grouse, they have not been shown to be significant to the immediate population status. Connelly *et al.* (2004, p. 10-3) have suggested that diseases and parasites may limit isolated sage-grouse populations, but that the effects of emerging diseases require additional study (see also Christiansen and Tate, in press, pp. 22-23).

Internal parasites which have been documented in the greater sage-grouse include the protozoans *Sarcosystis* spp. and *Tritrichomonas simoni*, blood parasites (including avian malaria (*Plasmodium* spp.), *Leucocytozoon* spp., *Haemoproteus* spp., and *Trypanosoma avium*, tapeworms (*Raillietina centrocerci* and *R. cesticillus*), gizzard worms (*Habronema* spp. and *Acuaria* spp.), cecal worms (*Heterakis gallinarum*), and filarid nematodes (*Ornithofilaria tuvensis*) (Honess 1955, pp.1-2; Hepworth 1962, p. 6: Thorne *et al.* 1982, p. 338; Connelly *et al.* 2004, pp. 10-4 to 10-6; Petersen 2004, p. 50; Christiansen and Tate, in press, pp. 9-13). None of these parasites have been known to cause mortality in the greater sage-grouse (Christiansen and Tate, in press, p. 8-13). Sub-lethal effects of these parasitic infections on sage-grouse have never been studied.

Greater sage-grouse host many external parasites, including lice, ticks, and dipterans (midges, flies, mosquitoes, and keds) (Connelly *et al.* 2004, pp. 10-6 to 10-7). Most ectoparasites do not produce disease, but can serve as disease vectors or cause mechanical injury and irritation (Thorne *et al.* 1982, p. 231). Ectoparasites can be detrimental to their hosts, particularly when the bird is stressed by inadequate habitat or nutritional conditions (Petersen 2004, p. 39). Some studies have suggested that lice infestations can affect sage-grouse mate selection (Boyce 1990, p. 266; Spurrier *et al.* 1991, p. 12; Deibert 1995, p. 37), but population impacts are not known (Connelly *et al.* 2004, p. 10-6).

Only a few parasitic infections in greater sage-grouse have been documented to result in fatalities, including the protozoan, *Eimeria* spp. (coccidiosis) (Connelly *et al.* 2004, p. 10-4), and possibly ixodid ticks (*Haemaphysalis cordeilishas*). Mortality is not 100 percent with coccidiosis, and young birds that survive an initial infection typically do not succumb to subsequent infections (Thorne *et al.* 1982, p. 112). Infections also tend to be localized to specific geographic areas. Most cases of coccidiosis in greater sage-grouse have been found where large numbers of birds congregated, resulting in soil and water contamination by fecal material (Scott 1940, p. 45; Honess and Post 1968, p. 20; Connelly *et al.* 2004, p. 10-4; Christiansen and Tate, in press, p. 3). While the role of this parasite in population regulation is unknown, Petersen (2004, p. 47) hypothesized that coccidiosis could be limiting for local populations, as this parasite causes decreased growth and resulted in significant mortality in young birds, thereby potentially limiting recruitment. However, no cases of sage-grouse mortality resulting from coccidiosis have been documented since the early 1960s (Connelly *et al.* 2004, p. 10-4), with the exception of two yearlings being held in captivity (Cornish 2009a, pers. comm.). One hypothesis for the apparent decline in occurrences of coccidiosis is the reduced density of sage-grouse, limiting the spread of the disease (Christiansen and Tate, in press, p. 14).

The only mortalities associated with ixodid ticks were found in association with a tularemia (*Francisella tularenis*) outbreak in Montana (Parker *et al.* 1932, p. 480; Christiansen and Tate, in press, p. 7). The sage-grouse mortality was likely from the pathological effects of the abnormally high number of feeding ticks found on the birds, as well as tularemia infection itself (Christiansen and Tate, in press, p.15). No other reports of tularemia have been recorded in greater sage-grouse (Christiansen and Tate, in press, p. 15).

Greater sage-grouse also are subject to a variety of bacterial, fungal, and viral pathogens. The bacteria *Salmonella* spp. has caused mortality in the greater sage-grouse and was apparently contracted through of exposure to contaminated water supplies around livestock stock tanks (Connelly *et al.* 2004, p. 10-7). However, it is unlikely that diseases associated with *Salmonella* spp. pose a significant risk to sage-grouse unless environmental conditions concentrate birds, resulting in contamination of limited water supplies by accumulated fecal material (Christiansen and Tate, in press, p. 15). A tentative documentation of *Mycoplasma* spp. in sage-grouse is known from Colorado (Hausleitner 2003, p. 147), but we found no other information to suggest this bacterium is either fatal or widespread. Other bacteria found in sage-grouse include avian tuberculosis (*Mycobacterium avium*), and avian cholera (*Pasteurella multocida*). These bacteria have never been identified as a cause of mortality in greater sage-grouse and the risk of exposure and hence, population effects, is low (Connelly *et al.* 2004, p. 10-7 to 10-8).

Sage-grouse afflicted with coccidiosis in Wyoming also were positive for *Escherichia coli* (Honess and Post 1968, p. 17). This bacterium is not believed to be a threat to wild populations of greater sage-grouse (Christiansen and Tate, in press, p. 15), as it has only been shown to cause acute mortality in captive birds kept in unsanitary conditions (Friend 1999, p. 125). One death from *Clostridium perfringens* has been recorded in a free-ranging adult male sage-grouse in Oregon (Hagen and Bildfell 2007, p. 545). Friend (1999, p. 123) mentions that outbreaks of *Clostridum* have been reported in greater sage-grouse, but the only information we located were two deaths reported from northeastern Wyoming (Cornish 2009a, pers. comm.). Christiansen and Tate (in press, p. 14) caution that given the persistence of this bacterium's spores in the soil, the resulting necrotic enteritis, especially when coupled with coccidiosis, may be a concern in small isolated populations.

One case of aspergillosis, a fungal disease, has been documented in sage-grouse, but there is no evidence to suggest this fungus plays a role in limiting greater sage-grouse populations (Connelly *et al.* 2004, p. 10-8; Petersen 2004, p. 45). Sage-grouse habitats are generally incompatible with the ecology of this disease due to their arid conditions.

Viruses could cause serious diseases in grouse species and potentially influence population dynamics (Petersen 2004, p. 46). However, prior to 2002, only avian infectious bronchitis (caused by a coronavirus) had been identified in the greater sage-grouse during necropsy. No clinical signs of the disease were observed.

West Nile virus was introduced into the northeastern United States in 1999 and has subsequently spread across North America (Marra *et al.* 2004, p.394). This virus is thought to have caused millions of wild bird deaths since its introduction (Walker and Naugle in press, p. 4), but most WNv mortality goes unnoticed or unreported (Ward *et al.* 2006, p. 101). The virus persists largely within a mosquito-bird-mosquito infection cycle (McLean 2006, p. 45). However, direct bird-to-bird transmission of the virus has been documented in several species (McLean 2006, pp. 54, 59) including the greater sage-grouse (Walker and Naugle in press, p. 13; Cornish 2009b, pers. comm.). The frequency of direct transmission has not been determined (McLean 2006, p. 54).

Impacts of WNv on the bird host varies by species with some species being relatively unaffected (e.g., common grackles (*Quiscalus quiscula*)) and others experiencing mortality rates of up to 68 percent (e.g., American crow (*Corvus brachyrhynchos*)) (Walker and Naugle in press, p. 4, and references therein). Greater sage-grouse are considered to have a high susceptibility to WNv, with resultant high levels of mortality (Clark *et al.* 2006, p. 19; McLean 2006, p. 54).

In sagebrush habitats, WNv transmission is primarily regulated by environmental factors, including temperature, precipitation, and anthropogenic water sources, such as stock ponds and coal-bed methane ponds, that support the mosquito vectors (Reisen *et al.* 2006, p. 309; Walker and Naugle in press, pp. 10-12). Cold ambient temperatures preclude mosquito activity and virus amplification, so transmission to and in sage-grouse is limited to the summer (mid-May to mid-September) (Naugle *et al.* 2005, p. 620; Zou *et al.* 2007, p. 4), with a peak in July and August (Walker and Naugle in press, p. 10). Reduced and delayed WNv transmission in sage-grouse has occurred in years with lower summer temperatures (Naugle *et al.* 2005, p. 621; Walker *et al.* 2007b, p. 694). In non-sagebrush ecosystems, high temperatures associated with drought conditions increase WNv transmission by allowing for more rapid larval mosquito development and shorter virus incubation periods (Shaman *et al.* 2005, p.134; Walker and Naugle in press, p. 11). Greater sage-grouse congregate in mesic habitats in the mid-late summer (Connelly *et al.* 2000, p. 971) thereby increasing the risk of exposure to mosquitoes. If WNv outbreaks coincide with drought conditions that aggregate birds in habitat near water sources, the risk of exposure to WNv will be elevated (Walker and Naugle in press, p. 11).

Greater sage-grouse inhabiting higher elevation sites in summer are likely less vulnerable to contracting WNv than birds at lower elevation as ambient temperatures are typically cooler (Walker and Naugle in press, p. 11). Greater sage-grouse populations in northwestern Colorado and western Wyoming are examples of high elevation populations with lower risk for impacts from WNv (Walker and Naugle in press, p. 26). Also, due to summer temperatures generally being lower in more northerly areas, sage-grouse populations that are in geographically more northern populations my be less susceptible than those at similar elevations farther south (Naugle *et al.* 2005, cited in Walker and Naugle in press, p. 11). Climate change could result in increased temperatures and thus potentially exacerbate the prevalence of WNv, and thereby impacts on greater sage-grouse, but this risk also depends on complex interactions with other environmental factors including precipitation and distribution of suitable water (Walker and Naugle in press, p. 12)

The primary vector of WNv in sagebrush ecosystems is *Culex tarsalis* (Naugle *et al.* 2004, p. 711; Naugle *et al.* 2005, p. 617; Walker and Naugle in press, p. 6). Individual mosquitoes may disperse as much as 18 km (11.2 mi) (Miller 2009, pers. comm.; Walker and Naugle in press, p. 7). This mosquito species is capable of overwinter survival and, therefore, can emerge as infected adults the following spring (Walker and Naugle in press, p. 8 and references therein), thereby decreasing the time for disease cycling (Miller 2009, pers. comm.). This ability may increase the occurrence of this virus at higher elevation populations or where ambient temperatures would otherwise be insufficient to sustain the entire mosquito-virus cycle.

In greater sage-grouse, mortality from WNv occurs at a time of year when survival is otherwise typically high for adult females (Schroeder *et al.* 1999, p.14; Aldridge and Brigham 2003, p. 30), thus potentially making these deaths additive and reducing average annual survival (Naugle *et al.* 2005, p. 621). WNv has been identified as a source of additive mortality in American white pelicans (*Pelecanus erythrorhynchos*) in the northern plains breeding colonies (Montana, North Dakota and South Dakota), and its continued impact has the potential to severely impact the entire pelican population (Sovada *et al.* 2008, p. 1030).

WNv was first detected in 2002 as a cause of greater sage-grouse mortalities in Wyoming (Walker and Naugle in press, p. 15). Data from four studies in the eastern half of the sage-grouse range (Alberta, Montana, and Wyoming; MZ I) showed survival in these populations declined 25 percent in July and August of 2003 as a result of the WNv infection (Naugle *et al.* 2004, p. 711). Populations of sage-grouse that were not affected by WNv showed no similar decline. Additionally, individual sage-grouse in exposed populations were 3.4 times more likely to die during July and August, the peak of WNv occurrence, than birds in non-exposed populations (Connelly *et al.* 2004, p. 10-9; Naugle *et al.* 2004, p. 711). Subsequent declines in both male and female lek attendance in infected areas in 2004 compared with years before WNv suggest outbreaks could contribute to local population extirpation (Walker *et al.* 2004, p. 4). One outbreak near Spotted Horse, Wyoming in 2003 was associated with the subsequent extirpation of the local breeding population, with five leks affected by the disease becoming inactive within 2 years (Walker and Naugle in press, p. 16). Lek surveys in northeastern Wyoming in 2004 indicated that regional sage-grouse populations did not decline, suggesting that the initial effects of WNv were localized (WGFD, unpublished data, 2004b).

Eight sage-grouse deaths resulting from WNv were identified in 2004: four from the Powder River Basin area of northeastern Wyoming and southeastern Montana, one from the northwestern Colorado, near the town of Yampa, and three in California (Naugle *et al.* 2005, p. 618). Fewer other susceptible hosts succumbed to the disease in 2004, suggesting that below average precipitation and summer temperatures may have limited mosquito production and disease transmission rates (Walker and Naugle in press, pp. 16-17). However, survival rates in greater sage-grouse in July and September of that year were consistently lower in areas with confirmed WNv mortalities than those without (avg. 0.86 and 0.96, respectively; Walker and Naugle in press, p. 17). There were no comprehensive efforts to track sage-grouse mortalities outside of these areas, so the actual distribution and extent of

WNv in sage-grouse in 2004 is unknown (70 FR 2270).

Mortality rates from WNv in northeastern Wyoming and southeastern Montana (MZ I) were between 2.4 (estimated minimum) and 28.9 percent (estimated maximum) in 2005 (Walker *et al.* 2007b, p. 693). Sage-grouse mortalities also were reported in California, Nevada, Utah, and Alberta, but no mortality rates were calculated (Walker and Naugle in press, p. 17). Mortality rates in 2006 in northeastern Wyoming ranged from 5 to15 percent of radio-marked females (Walker and Naugle in press, p. 17). Mortality rates in South Dakota among radio-marked juvenile sage-grouse ranged between 6.5 and 71 percent in the same year (Kaczor 2008, p. 63). Large sage-grouse mortality events, likely the result of WNv, were reported in the Jordan Valley and near Burns, Oregon (over 60 birds), and in several areas of Idaho and along the Idaho-Nevada border (over 55 birds) (Walker and Naugle in press, p. 18). While most of the carcasses had decomposed and, therefore, were not testable, results for the few that were tested showed that they died from WNv. Mortality rates in these areas were not calculated. However, the hunting season in Owyhee County, Idaho, was closed that year due to the large number of birds that succumbed to the disease (USGS 2006, p. 1; Walker and Naugle in press, p. 18).

In 2007, a WNv outbreak in South Dakota contributed to a 44-percent mortality rate among 80 marked females (Walker and Naugle in press, p. 18). Juvenile mortality rates in 2007 in the same area ranged from 20.8 to 62.5 percent (Kaczor 2008, p. 63), reducing recruitment the subsequent spring by 2 to 4 percent (Kaczor 2008, p. 65). Twenty-six percent of radio-marked females in northeastern Montana died during a 2–week period immediately following the first detection of WNv in mosquito pools. Two of those females were confirmed dead from WNv (Walker and Naugle in press, p. 18). In the Powder River Basin, WNv-related mortality among 85 marked females was between 8 and 21 percent (Walker and Naugle in press, p. 18). A 52-percent decline in the number of males attending leks in North Dakota between 2007 and 2008 also were associated with WNv mortality in 2007 that prompted the State wildlife agency to close the hunting season in 2008 (North Dakota Game and Fish 2008, entire) and 2009 (Robinson 2009, pers. comm.). The Duck Valley Indian Reservation along the border of Nevada and Idaho closed their hunting season in 2006 due to population declines resulting from WNv (Gossett 2008, pers. comm.). WNv is still present in that area, with continued population declines (50.3 percent of average males per lek from 2005 to 2008) (Dick 2008, p. 2), and the hunting season remains closed. The hunting season was closed in most of the adjacent Owyhee County, Idaho for the same reason in both 2008 and 2009 (Dick 2008, pers. comm.; IDFG 2009).

Only Wyoming reported WNv mortalities in sage-grouse in 2008 (Cornish 2009c, pers. comm.). However, with the exceptions of Colorado, California, and Idaho, research on sage-grouse in other States is limited, minimizing the ability to identify mortalities from the disease, or recover infected birds before tissue deterioration precludes testing. Three sage-grouse deaths were confirmed in 2009 in Wyoming (Cornish 2009c, pers. comm.), two in Idaho (Moser 2009, pers. comm.) and one other is suspected in Utah (Olsen 2009, pers. comm.).

Greater sage-grouse deaths resulting from WNv have been detected in 10 States and 1 Canadian province. To date, no sage-grouse mortality from WNv has been identified in either Washington State or Saskatchewan. However, it is likely that sage-grouse have been infected in Saskatchewan based on known patterns of sage-grouse in infected areas of Montana (Walker and Naugle in press, p. 15). Also, WNv has been detected in other species within the range of greater sage-grouse in Washington (USGS 2009).

In 2005, we reported that there was little evidence that greater sage-grouse can survive a WNv infection (70 FR 2270). This conclusion was based on the lack of sage-grouse found to have antibodies to the virus and from laboratory studies in which all sage-grouse exposed to the virus, at varying doses, died within 8 days or less (70 FR 2270; Clark *et al.* 2006, p. 17). These data suggested that sage-grouse do not develop a resistance to the disease, and death is certain once an individual is exposed (Clark *et al.* 2006, p. 18). However, 6 of 58 females (10.3 percent) birds captured in the spring of 2005 in northeastern Wyoming and southeastern Montana were seropositive for neutralizing antibodies, which suggests they were exposed to the virus the previous fall and survived an infection. Additional, but significantly fewer (2 of 109, or 1.8 percent) seropositive females were found in the spring of 2006 (Walker *et al.* 2007b, p. 693). Of approximately 1,400 serum tests on sage-grouse from South Dakota, Montana, Wyoming and Alberta, only 8 tested positive for exposure to WNv (Cornish 2009dpers. comm.), suggesting that survival is extremely low. Seropositive birds have not been reported from other parts of the species' range (Walker and Naugle in press, p. 20).

The duration of immunity conferred by surviving an infection is unknown (Walker and Naugle in press, p. 20). It also is unclear whether sage-grouse have sub-lethal or residual effects resulting from a WNv infection, such as reduced productivity or overwinter survival (Walker *et al.* 2007b, p. 694). Other bird species infected with WNv have been documented to suffer from chronic symptoms, including reduced mobility, weakness, disorientation, and lack of vigilance (Marra *et al.* 2004, p. 397; Nemeth *et al.* 2006, p. 253), all of which may affect survival, reproduction, or both (Walker and Naugle in press, p. 20). Reduced productivity in American white pelicans has been attributed to WNv (Sovada *et al.* 2008, p.1030).

Several variants of WNv have emerged since the original identification of the disease in the United States in 1999. One variant, termed NY99, has proven to be more virulent than the original virus strain of WNv, increasing the frequency of disease cycling (Miller 2009, pers. comm.). This constant evolution of the virus could limit resistance development in the greater sage-grouse.

Walker and Naugle (in press, pp. 20-24) modeled variability in greater sage-grouse population growth for the next 20 years based on current conditions under three WNv impact scenarios. These scenarios included: (1) no mortalities from WNv; (2) WNv- related mortality based on rates of observed infection and mortality rate data from 2003 to 2007; and (3) WNv-related mortality with increasing resistance to the disease over time. The addition of WNv-related mortality (scenario 2) resulted in a reduction of population growth. The proportion of resistant individuals in the modeled population increased marginally over the 20–year projection periods, from 4 to 15 percent, under the increasing resistance scenario (scenario 3). While this increase in the proportion of resistant individuals did reduce the projected WNv rates, the authors caution that the presence of neutralizing antibodies in the live birds does not always indicate that these birds are actually resistant to infection and disease (Walker and Naugle in press, p. 25).

Additional models predicting the prevalence of WNv suggest that new sources of anthropogenic surface waters (e.g., coal-bed methane discharge ponds), increasing ambient temperatures, and a mosquito parasite

that reduces the length of time the virus is present in the vector before the mosquito can spread the virus all suggest the impacts of this disease are likely to increase (Miller 2008, pers. comm.). However, the extent to which this will occur, and where, is unclear and difficult to predict because several conditions that support the WNv cycle must coincide for an outbreak to occur.

Human-created water sources in sage-grouse habitat known to support breeding mosquitoes that transmit WNv include overflowing stock tanks, stock ponds, irrigated agricultural fields, and coal-bed natural gas discharge ponds (Zou *et al.* 2006, p. 1035). For example, from 1999 through 2004, potential mosquito habitats in the Powder River Basin of Wyoming and Montana increased 75 percent (619 ha to 1084.5 ha; 1259 ac to 2680) primarily due to the increase of small coal-bed natural gas water discharge ponds (Zou *et al.* 2006, p. 1034). Additionally, water developments installed in arid sagebrush landscapes to benefit wildlife continue to be common. Several scientists have expressed concern regarding the potential for exacerbating WNv persistence and spread due to the proliferation of surface water features (e.g., Friend *et al.*, 2001, p. 298; Zou *et al.* 2006, p.1040; Walker *et al.* 2007b, p. 695; Walker and Naugle in press, p. 27). Walker *et al.* (2007a, p. 694) concluded that impacts from WNv will depend less on resistance to the disease than on temperatures and changes in vector distribution. Zou *et al.* (2006, p. 1040) cautioned that the continuing development of coal-bed natural gas facilities in Wyoming and Montana contributes to maintaining, and possibly increasing WNv on that landscape through the maintenance and proliferation of surface water.

The long-term response of different sage-grouse populations to WNv infections is expected to vary markedly depending on factors that influence exposure and susceptibility, such as temperature, land uses, and sage-grouse population size (Walker and Naugle in press, p. 25). Small, isolated, or genetically limited populations are at higher risk as an infection may reduce population size below a threshold where recovery is no longer possible, as observed with the extirpated population near Spotted Horse, Wyoming (Walker and Naugle in press, p. 25). Larger populations may be able to absorb impacts resulting from WNv as long as the quality and extent of available habitat supports positive population growth (Walker and Naugle in press, p. 25). However, impacts from this disease may act synergistically with other stressors resulting in reduction of population size, bird distribution, or persistence (Walker *et al.* 2007a, p. 2652). WNv persists on the landscape after it first occurs as an epizootic, suggesting this virus will remain a long-term issue in affected areas (McLean 2006, p. 50).

Proactive measures to reduce the impact of WNv on greater sage-grouse have been limited and are typically economically prohibitive. Fowl vaccines used on captive sage-grouse were largely ineffective (mortality rates were reduced from 100 to 80 percent in five birds) (Clark *et al.* 2006, p. 17; Walker and Naugle in press, p. 27). Development of a sage-grouse specific vaccine would require a market incentive and development of an effective delivery mechanism for large numbers of birds. Currently, the delivery mechanism is via intramuscular injection (Marra *et al.* 2004, p. 399; Walker and Naugle in press, p. 27), which is not feasible for wild populations. Vaccinations would likely only benefit the individuals receiving the vaccine, and not their offspring, so vaccination would have to occur on an annual basis (Walker and Naugle in press, p. 27, and references therein).

Mosquito production from human-created water sources could be minimized if water produced during coal-bed natural gas development were re-injected rather than discharged to the surface (Doherty 2007, p. 81). Mosquito control programs for reducing the number of adult mosquitoes may reduce the risk of WNv, but only if such methods are consistently and appropriately implemented (Walker and Naugle in press, p. 28). Many coal-bed natural gas companies in northeastern Wyoming (MZ I) have identified use of mosquito larvicides in their management plans (Big Horn Environmental Consultants in litt., 2009, p. 3). However, we could find no information on the actual use of the larvicides or their effectiveness. One experimental treatment in the area did report that mosquito larvae numbers were less in ponds treated with larvicides than those that were not (Big Horn Environmental Consultants in litt., 2009, pp. 5-7) but statistical analyses were not conducted. While none of the sage-grouse mortalities in the treated areas were due to WNv (Big Horn Environmental Consultants 2009, p.3), the study design precluded actual cause and effect analyses; therefore, the results are inconclusive. The benefits of mosquito control in potentially reducing the incidence of WNv in sage-grouse need to be considered in light of the potential detrimental or cascading ecological effects of widespread spraying (Marra *et al.* 2004, p. 401).

Small populations, such as the Columbia Basin area in Washington State or the subpopulations within the Bi-State area along the California and Nevada border also may be at high risk of extirpation simply due to their low population numbers and the additive mortality WNv causes (Christiansen and Tate, in press, p. 21). Larger populations may be better able to sustain losses from WNv (Walker and Naugle in press, p. 25) simply due to their size. However, as other impacts to grouse and their habitats described under Factor A affect these areas, these secure areas or sage-grouse ''refugia'' also may be at risk (e.g., southwestern Wyoming, south-central Oregon). Existing and developing models suggest that the occurrence of WNv is likely to increase throughout the range of the species into the future.

Summary of Disease

Although greater sage-grouse are host to a wide variety of diseases and parasites, few have resulted in population effects, with the exception of WNv. Many large losses from bacterial and coccidial infections have resulted when large groups of grouse were restricted to limited habitats, such as springs and seeps in the late summer. If these habitats become restricted due to habitat losses and degradation, or changes in climate, these easily transmissible diseases may become more prevalent. Sub-lethal effects of these disease and parasitic infections on sage-grouse have never been studied, and, therefore, are unknown.

Substantial new information on WNv and impacts on the greater sage-grouse has emerged since we completed our finding in 2005. The virus is now distributed throughout the species' range, and affected sage-grouse populations experience high mortality rates with resultant, often large reductions in local population numbers. Infections in northeastern Wyoming, southeastern Montana, and the Dakotas seem to be the most persistent, with mortalities recorded in that area every year since WNv was first detected in sage-grouse. Limited information suggests that sage-grouse may be able to survive an infection; however, because of the apparent low level of immunity and continuing changes within the virus, widespread resistance is unlikely.

There are few regular monitoring efforts for WNv in greater sage-grouse; most detection is the result of research with radio-marked birds, or the incidental discovery of large mortalities. In Saskatchewan, where the greater

sage-grouse is listed as an endangered species, no monitoring for WNv occurs (McAdams 2009, pers. comm.). Without a comprehensive monitoring program, the extent and effects of this disease on greater sage-grouse rangewide cannot be determined. However, it is clear that WNv is persistent throughout the range of the greater sage-grouse, and is likely a locally significant mortality factor. We anticipate that WNv will persist within sage-grouse habitats indefinitely, and will remain a threat to greater sage-grouse until they develop a resistance to the virus.

The most significant environmental factors affecting the persistence of WNv within the range of sage-grouse are ambient temperatures and surface water abundance and development. The continued development of anthropogenic sources of warm standing water throughout the range of the species will likely increase the prevalence of the virus in sage-grouse, as predicted by Walker and Naugle (in press, pp. 20-24; see discussion above). Areas with intensive energy development may be at a particularly high risk for continued WNv mortalities due to the development of surface water features, and the continued loss and fragmentation of habitats (see discussion of energy development above). Resultant changes in temperature as a result of climate change also may exacerbate the prevalence of WNv and thereby impacts on greater sage-grouse unless they develop resistance to the virus,

With the exception of WNv, we could find no evidence that disease is a concern with regard to sage-grouse persistence across the species' range. WNv is a significant mortality factor for greater sage-grouse when an outbreak occurs, given the bird's lack of resistance and the continued proliferation of water sources throughout the range of the species. However, a complex set of environmental and biotic conditions that support the WNv cycle must coincide for an outbreak to occur. Currently the annual patchy distribution of the disease is keeping the impacts at a minimum. The prevalence of this disease is likely to increase across the species' range.

We find that the threat of disease is not significant to the point that the greater sage-grouse warrants listing under the Act as threatened or endangered at this time

Predation

Predation is the most commonly identified cause of direct mortality for sage-grouse during all life stages (Schroeder *et al.* 1999, p. 9; Connelly *et al.* 2000b, p. 228; Connelly *et al.* in press a, p. 23). However, sage-grouse have co-evolved with a variety of predators, and their cryptic plumage and behavioral adaptations have allowed them to persist despite this mortality factor (Schroeder *et al.* 1999, p. 10; Coates 2008 p. 69; Coates and Delehanty 2008, p. 635; Hagen in press, p. 3). Until recently, there has been little published information that indicates predation is a limiting factor for the greater sage-grouse (Connelly *et al.* 2004, p. 10-1), particularly where habitat quality has not been compromised (Hagen in press, p. 3). Although many predators will consume sage-grouse, none specialize on the species (Hagen in press, p. 5). However, generalist predators have the greatest effect on ground nesting birds because predator numbers are independent of prey density (Coates 2007, p. 4).

Major predators of adult sage-grouse include many species of diurnal raptors (especially the golden eagle), red foxes, and bobcats (*Lynx rufus*) (Hartzler 1974, pp. 532-536; Schroeder *et al.* 1999, pp. 10-11; Schroeder and Baydack 2001, p. 25; Rowland and Wisdom 2002, p. 14; Hagen in press, pp. 4-5). Juvenile sage-grouse also are killed by many raptors as well as common ravens, badgers (*Taxidea taxus)*, red foxes, coyotes and weasels (*Mustela* spp.) (Braun 1995, entire; Schroeder *et al.* 1999, p. 10). Nest predators include badgers, weasels, coyotes, common ravens, American crows, and magpies (*Pica* spp.). Elk (Holloran and Anderson 2003, p.309) and domestic cows (*Bovus* spp.) (Coates *et al.* 2008, pp. 425-426), have been observed to eat sage-grouse eggs. Ground squirrels (*Spermophilus* spp.) also have been identified as nest predators (Patterson 1952, p. 107; Schroeder *et al.* 1999, p. 10; Schroeder and Baydack 2001, p. 25), but recent data show that they are physically incapable of puncturing eggs (Holloran and Anderson 2003, p 309; Coates *et al.* 2008, p 426; Hagen in press, p. 6). Several other small mammals visited sage-grouse nests monitored by videos in Nevada, but none resulted in predation events (Coates *et al.* 2008, p. 425). Great Basin gopher snakes (*Pituophis catenifer deserticola*) were observed at nests, but no predation occurred.

Adult male greater sage-grouse are very susceptible to predation while on the lek (Schroeder *et al.* 1999, p. 10; Schroeder and Baydack 2000, p. 25; Hagen in press, p. 5), presumably because they are very conspicuous while performing their mating displays. Because leks are attended daily by numerous birds, predators also may be attracted to these areas during the breeding season (Braun 1995). Connelly *et al.* (2000b, p.228) found that among 40 radio-collared males, 83 percent of the mortality was due to predation and 42 percent of those mortalities occurred during the lekking season (March through June). Adult female greater sage-grouse are susceptible to predators while on the nest but mortality rates are low (Hagen in press, p. 6). Hens will abandon their nest when disturbed by predators (Patterson 1952, p. 110), likely reducing this mortality (Hagen in press, p. 6). Connelly *et al.* (2000b, p. 228) found that among 77 radio-collared adult hens that died, 52 percent of the mortality was due to predation, and 52 percent of those mortalities occurred between March and August, which includes the nesting and brood-rearing periods. Because sage-grouse are highly polygynous with only a few males breeding per year, sage-grouse populations are likely more sensitive to predation upon females. Predation of adult sage-grouse is low outside the lekking, nesting, and brood-rearing season (Connelly *et al.* 2000b, p. 230; Naugle *et al.* 2004, p. 711; Moynahan *et al.* 2006, p. 1536; Hagen in press, p. 6).

Estimates of predation rates on juveniles are limited due to the difficulties in studying this age class (Aldridge and Boyce 2007, p. 509; Hagen in press, p.8). Chick mortality from predation ranged from 27 percent to 51 percent in 2002 and 10 percent to 43 percent in 2003 on three study sites in Oregon (Gregg *et al.* 2003a, p. 15; 2003b, p. 17). Mortality due to predation during the first few weeks after hatching was estimated to be 82 percent (Gregg *et al.* 2007, p. 648). Based on partial estimates from three studies, Crawford *et al.* (2004, p. 4 and references therein) reported survival of juveniles to their first breeding season was low, approximately 10 percent, and predation was one of several factors they cited as affecting juvenile survival. However, Connelly *et al*, (in press a, p. 19) point out that the estimate of 10 percent survival of juveniles likely is biased low, as at least two of the four studies that were the basis of this estimate were from areas with fragmented or otherwise marginal habitat.

Sage-grouse nests are subject to varying levels of predation. Predation can be total (all eggs destroyed) or partial (one or more eggs destroyed). However, hens abandon nests in either case (Coates, 2007, p. 26). Gregg *et al.* (1994, p. 164) reported that over a 3–year period in Oregon, 106 of 124 nests (84 percent) were preyed upon (Gregg *et al.* 1994, p. 164). Non-predated nests

had greater grass and forb cover than predated nests. Patterson (1952, p.104) reported nest predation rates of 41 percent in Wyoming. Holloran and Anderson (2003, p. 309) reported a predation rate of 12 percent (3 of 26) in Wyoming. In a 3–year study involving four study sites in Montana, Moynahan *et al.* (2007, p. 1777) attributed 131 of 258 (54 percent) of nest failures to predation in Montana, but the rates may have been inflated by the study design (Connelly *et al.* in press a, p. 17). Re-nesting efforts may compensate for the loss of nests due to predation (Schroeder 1997, p. 938), but re-nesting rates are highly variable (Connelly *et al.* in press a, p. 16). Therefore, re-nesting is unlikely to offset losses due to predation. Losses of breeding hens and young chicks to predation potentially can influence overall greater sage-grouse population numbers, as these two groups contribute most significantly to population productivity (Baxter *et al.* 2008, p. 185; Connelly *et al*, in press a, p. 18).

Nesting success of greater sage-grouse is positively correlated with the presence of big sagebrush and grass and forb cover (Connelly *et al.* 2000, p. 971). Females actively select nest sites with these qualities (Schroeder and Baydack 2001, p. 25; Hagen *et al.* 2007, p. 46). Nest predation appears to be related to the amount of herbaceous cover surrounding the nest (Gregg *et al.* 1994, p. 164; Braun 1995; DeLong *et al.* 1995, p. 90; Braun 1998; Coggins 1998, p. 30; Connelly *et al.* 2000b, p. 975; Schroeder and Baydack 2001, p. 25; Coates and Delehanty 2008, p. 636). Loss of nesting cover from any source (e.g., grazing, fire) can reduce nest success and adult hen survival. However, Coates (2007, p. 149) found that badger predation was facilitated by nest cover as it attracts small mammals, a badger's primary prey. Similarly, habitat alteration that reduces cover for young chicks can increase their rate of predation (Schroeder and Baydack 2001, p. 27).

In a review of published nesting studies, Connelly *et al.* (in press a, p. 17) reported that nesting success was greater in unaltered habitats versus altered habitats. Where greater sage-grouse habitat has been altered, the influx of predators can decrease annual recruitment into a population (Gregg *et al.* 1994, p. 164; Braun 1995; Braun 1998; DeLong *et al.* 1995, p. 91; Schroeder and Baydack 2001, p. 28; Coates 2007, p. 2; Hagen in press, p. 7). Ritchie *et al.* (1994, p. 125), Schroeder and Baydack (2001, p. 25), Connelly *et al.* (2004, p. 7-23), and Summers *et al.* (2004, p. 523) have reported that agricultural development, landscape fragmentation, and human populations have the potential to increase predation pressure on all life stages of greater sage-grouse by forcing birds to nest in less suitable or marginal habitats, increasing travel time through habitats where they are vulnerable to predation, and increasing the diversity and density of predators.

Abundance of red fox and corvids, which historically were rare in the sagebrush landscape, has increased in association with human-altered landscapes (Sovada *et al.* 1995, p. 5). In the Strawberry Valley of Utah, low survival of greater sage-grouse may have been due to an unusually high density of red foxes, which apparently were attracted to that area by anthropogenic activities (Bambrough *et al.* 2000). Ranches, farms, and housing developments have resulted in the introduction of nonnative predators including domestic dogs (*Canis domesticus*) and cats (*Felis domesticus*) into greater sage-grouse habitats (Connelly *et al.* 2004, p. 7-23). Local attraction of ravens to nesting hens may be facilitated by loss and fragmentation of native shrublands, which increases exposure of nests to potential predators (Aldridge and Boyce 2007, p. 522; Bui 2009, p. 32). The presence of ravens was negatively associated with grouse nest and brood fate (Bui 2009, p. 27).

Raven abundance has increased as much as 1500 percent in some areas of western North America since the 1960s (Coates and Delehanty 2010, p. 244 and references therein). Human-made structures in the environment increase the effect of raven predation, particularly in low canopy cover areas, by providing ravens with perches (Braun 1998, pp.145-146; Coates 2007, p. 155; Bui 2009, p. 2). Reduction in patch size and diversity of sagebrush habitat, as well as the construction of fences, powerlines, and other infrastructure also are likely to encourage the presence of the common raven (Coates *et al.* 2008, p. 426; Bui 2009, p. 4). For example, raven counts have increased by approximately 200 percent along the Falcon-Gondor transmission line corridor in Nevada (Atamian *et al.* 2007, p. 2). Ravens contributed to lek disturbance events in the areas surrounding the transmission line (Atamian *et al.* 2007, p. 2), but as a cause of decline in surrounding sage-grouse population numbers, it could not be separated from other potential impacts, such as WNv.

Holloran (2005, p. 58) attributed increased sage-grouse nest depredation to high corvid abundances, which resulted from anthropogenic food and perching subsidies in areas of natural gas development in western Wyoming. Bui (2009, p. 31) also found that ravens used road networks associated with oil fields in the same Wyoming location for foraging activities. Holmes (unpubl. data) also found that common raven abundance increased in association with oil and gas development in southwestern Wyoming. The influence of synanthropic predators in the Wyoming Basin is important as this area has one of the few remaining clusters of sagebrush landscapes and the most highly connected network of sage-grouse leks (Knick and Hanser in press, p.18). Raven abundance was strongly associated with sage-grouse nest failure in northeastern Nevada, with resultant negative effects on sage-grouse reproduction (Coates 2007, p. 130). The presence of high numbers of predators within a sage-grouse nesting area may negatively affect sage-grouse productivity without causing direct mortality. Coates (2007, p. 85-86) suggested that ravens may reduce the time spent off the nest by female sage-grouse, thereby potentially compromising their ability to secure sufficient nutrition to complete the incubation period.

As more suitable grouse habitat is converted to oil fields, agriculture and other exurban development, grouse nesting and brood-rearing become increasingly spatially restricted (Bui 2009, p. 32). High nest densities which result from habitat fragmentation or disturbance associated with the presence of edges, fencerows, or trails may increase predation rates by making foraging easier for predators (Holloran 2005, p. C37). In some areas even low but consistent raven presence can have a major impact on sage-grouse reproductive behavior (Bui 2009, p. 32). Leu and Hanser (in press, pp. 24-25) determined that the influence of the human footprint in sagebrush ecosystems may be underestimated due to varying quality of spatial data. Therefore, the influence of ravens and other predators associated with human activities may be under-estimated.

Predator removal efforts have sometimes shown short-term gains that may benefit fall populations, but not breeding population sizes (Cote and Sutherland 1997, p. 402; Hagen in press, p. 9; Leu and Hanser in press, p. 27). Predator removal may have greater benefits in areas with low habitat quality, but predator numbers quickly rebound without continual control (Hagen in press, p. 9). Red fox removal in Utah appeared to increase adult sage-grouse survival and productivity, but the study did not compare these rates against other non-removal areas, so

inferences are limited (Hagen in press, p. 11). Slater (2003, p. 133) demonstrated that coyote control failed to have an effect on greater sage-grouse nesting success in southwestern Wyoming. However, coyotes may not be an important predator of sage-grouse. In a coyote prey base analysis, Johnson and Hansen (1979, p. 954) showed that sage-grouse and bird egg shells made up a very small percentage (0.4-2.4 percent) of analyzed scat samples. Additionally, coyote removal can have unintended consequences resulting in the release of mesopredators, many of which, like the red fox, may have greater negative impacts on sage-grouse (Mezquida *et al.* 2006, p. 752). Removal of ravens from an area in northeastern Nevada caused only short-term reductions in raven populations (less than 1 year) as apparently transient birds from neighboring sites repopulated the removal area (Coates 2007, p. 151). Additionally, badger predation appeared to partially compensate for decreases in raven removal (Coates 2007, p. 152). In their review of literature regarding predation, Connelly *et al.* (2004, p. 10-1) noted that only two of nine studies examining survival and nest success indicated that predation had limited a sage-grouse population by decreasing nest success, and both studies indicated low nest success due to predation was ultimately related to poor nesting habitat. Bui (2009, pp. 36-37) suggested removal of anthropogenic subsidies (e.g., landfills, tall structures) may be an important step to reducing the presence of sage-grouse predators. Leu and Hanser (in press, p. 27) also argue that reducing the effects of predation on sage-grouse can only be effectively addressed by precluding these features.

Summary of Predation

Greater sage-grouse are adapted to minimize predation by cryptic plumage and behavior. Because sage-grouse are prey, predation will continue to be an effect on the species. Where habitat is not limited and is of good quality, predation is not a threat to the persistence of the species. However, sage-grouse may be increasingly subject to levels of predation that would not normally occur in the historically contiguous unaltered sagebrush habitats. The impacts of predation on greater sage-grouse can increase where habitat quality has been compromised by anthropogenic activities (such as exurban development, road development) (e.g. Coates 2007, p. 154, 155; Bui 2009, p. 16; Hagen in press, p. 12). Landscape fragmentation, habitat degradation, and human populations have the potential to increase predator populations through increasing ease of securing prey and subsidizing food sources and nest or den substrate. Thus, otherwise suitable habitat may change into a habitat sink for grouse populations (Aldridge and Boyce 2007, p. 517). Anthropogenic influences on sagebrush habitats that increase suitability for ravens may limit sage-grouse populations (Bui 2009, p. 32). Current land-use practices in the intermountain West favor high predator (in particular, raven) abundance relative to historical numbers (Coates *et al.* 2008, p. 426). The interaction between changes in habitat and predation may have substantial effects at the landscape level (Coates 2007, p. 3).

The studies presented here suggest that, in areas of intensive habitat alteration and fragmentation, sage-grouse productivity and, therefore, populations could be negatively affected by increasing predation. Predators could already be limiting sage-grouse populations in southwestern Wyoming and northeastern Nevada (Coates 2007, p. 131; Bui 2009, p. 33).

The influence of synanthropic predators in southwestern Wyoming may be particularly significant as this area has one of the few remaining sagebrush landscapes and the most highly connected network of sage-grouse leks (Wisdom *et al.* in press, p. 24). Unfortunately, except for the few studies presented here, data are lacking that definitively link sage-grouse population trends with predator abundance. However, where habitats have been altered by human activities, we believe that predation could be limiting local sage-grouse populations. As more habitats face development, even dispersed development, we expect the risk of increased predation to spread, possibly with negative effects on the sage-grouse population trends. Studies of the effectiveness of predator control have failed to demonstrate an inverse relationship between the predator numbers and sage-grouse nesting success or populations numbers.

Except in localized areas where habitat is compromised, we found no evidence to suggest predation is limiting greater sage-grouse populations. However, landscape fragmentation is likely contributing to increased predation on this species.

Summary of Factor C

With regard to disease, the only concern is the potential effect of WNv. This disease is distributed throughout the species' range and affected sage-grouse populations experience high mortality rates (near 100 percent lethality), with resultant reductions in local population numbers. Risk of exposure varies with factors such as elevation, precipitation regimes, and temperature. The continued development of anthropogenic water sources throughout the range of the species, some of which are likely to provide suitable conditions for breeding mosquitoes that are part of the WNv cycle, will likely increase the prevalence of the virus in sage-grouse. We anticipate that WNv will persist within sage-grouse habitats indefinitely and may be exacerbated by factors (e.g., climate change) that increase ambient temperatures and the presence of the vector on the landscape. The occurrence of WNv occurrence is sporadic across the species' range, and a complex set of environmental and biotic conditions that support the WNv cycle must coincide for an outbreak to occur.

Where habitat is not limited and is of good quality, predation is not a significant threat to the species. We are concerned that continued landscape fragmentation will increase the effects of predation on this species, potentially resulting in a reduction in sage-grouse productivity and abundance in the future. However, there is very limited information on the extent to which such effects might be occurring. Studies of the effectiveness of predator control have failed to demonstrate an inverse relationship between the predator numbers and sage-grouse nesting success or population numbers, i.e., predator removal activities have not resulted in increased populations. Mortality due to nest predation by ravens or other human-subsidized predators is increasing in some areas, but there is no indication this is causing a significant rangewide decline in population trends. Based on the best scientific and commercial information available, we conclude that predation is not a significant threat to the species such that the species requires listing under the Act as threatened or endangered.

Factor D: Inadequacy of Existing Regulatory Mechanisms.

Under this factor, we examine whether threats to the greater sage-grouse are adequately addressed by existing regulatory mechanisms. Existing regulatory mechanisms that could provide some protection for greater sage-grouse include: (1) local land use laws, processes, and ordinances; (2) State laws and regulations; and (3) Federal laws and regulations. Regulatory mechanisms, if they exist, may preclude listing if such mechanisms are judged to adequately

address the threat to the species such that listing is not warranted. Conversely, threats on the landscape are exacerbated when not addressed by existing regulatory mechanisms, or when the existing mechanisms are not adequate (or not adequately implemented or enforced).

Local Land Use Laws, Processes, and Ordinances

Approximately 31 percent of the sagebrush habitats within the sage-grouse MZs are privately owned (Table 3; Knick in press, p. 39) and are subject only to local regulations unless Federal actions are associated with the property (e.g., wetland modification, Federal subsurface owner). We conducted extensive internet searches and contacted State and local working group contacts from across the range of the species to identify local regulations that may provide protection to the greater sage-grouse. We identified only one regulation at the local level that specifically addresses sage-grouse. Washington County, Idaho, Planning and Zoning has developed a draft Comprehensive Plan which states that ''Sage Grouse leks...and a buffer around those leks, shall be protected from the disruption of development'' (Washington County, 2009, p. 27). As this plan is still incomplete, and the final buffer distance has not been identified, it cannot currently provide the necessary regulatory provisions to be considered further. Sage-grouse were mentioned in other county and local plans across the range, and some general recommendations were made regarding effects to sage-grouse associated with land uses. However, we could find no other examples of county-planning and enforceable zoning regulations specific to sage-grouse.

State Laws and Regulations

State laws and regulations may impact sage-grouse conservation by providing specific authority for sage-grouse conservation over lands which are directly owned by the State; providing broad authority to regulate and protect wildlife on all lands within their borders; and providing a mechanism for indirect conservation through regulation of threats to the species (e.g. noxious weeds).

In general, States have broad authority to regulate and protect wildlife within their borders. All State wildlife agencies across the range of the species manage greater sage-grouse as resident native game birds except for Washington (Connelly *et al.* 2004, p. 6-3). In Washington, the species has been listed as a State-threatened species since 1998 and is managed in accordance with the State's provisions for such species (Stinson *et al.* 2004, p. 1). For example, killing greater sage-grouse is banned in Washington, and State-owned agricultural and grazing lands must adhere to standards regarding upland plant and vegetative community health that protect habitat for the species (Stinson *et al.* 2004, p. 55). However, lands owned by the Washington Department of Natural Resources continue to be converted from sagebrush habitat to croplands (Stinson *et al.* 2004, p. 55), which results in a loss of habitat for sage-grouse. Therefore, the provisions to protect sage-grouse in this State do not provide adequate protections for us to consider.

All States across the range of greater sage-grouse have laws and regulations that identify the need to conserve wildlife populations and habitat, including greater sage-grouse (Connelly *et al.* 2004, p. 2-22-11). As an example, in Colorado, ''wildlife and their environment'' are to be protected, preserved, enhanced and managed (Colorado Revised Statutes, Title 33, Article 1–101 in Connelly *et al.* 2004, p. 2-3). Laws and regulations in Oregon, Idaho, South Dakota, and California have similar provisions (Connelly *et al.* 2004, pp. 2-2 to 2-4, 2-6 to 2-8). However, these laws and regulations are general in nature and have not provided the protection to sage-grouse habitat necessary to protect the species from the threats described in Factor A above.

All of the states within the range of the sage-grouse have state school trust lands that they manage for income to support their schools. With the exception of Wyoming (see discussion below), none of the states have specific regulations to ensure that the management of the state trust lands is consistent with the needs of sage-grouse. Thus there are currently no regulatory mechanisms on state trust lands to ensure conservation of the species.

On September 26, 2008, the Governor of Nevada signed an executive order calling for the preservation and protection of sage-grouse habitat in the State of Nevada. The executive order directs the NDOW to ''continue to work with state and federal agencies and the interested public'' to implement the Nevada sage-grouse conservation plan. The executive order also directs other State agencies to coordinate with the NDOW in these efforts. Although directed specifically at sage-grouse conservation, the executive order is broadly worded and does not outline specific measures that will be undertaken to reduce threats and ensure conservation of sage-grouse in Nevada.

The California Environmental Quality Act (CEQA) (Public Resources Code sections 21000–21177), requires full disclosure of the potential environmental impacts of projects proposed in the State of California. Section 15065 of the CEQA guidelines requires a finding of significance if a project has the potential to ''reduce the number or restrict the range of a rare or endangered plant or animal.'' Under these guidelines sage-grouse are given the same protection as those species that are officially listed within the State. However, the lead agency for the proposed project has the discretion to decide whether to require mitigation for resource impacts, or to determine that other considerations, such as social or economic factors, make mitigation infeasible (CEQA section 21002). In the latter case, projects may be approved that cause significant environmental damage, such as destruction of endangered species, their habitat, or their continued existence. Therefore, protection of listed species through CEQA is dependent upon the discretion of the agency involved, and cannot be considered adequate protection for sage-grouse.

In Wyoming, the Governor issued an executive order on August 1, 2008, mandating special management for all State lands within sage-grouse ''Core Population Areas'' (State of Wyoming 2008, entire). Core Population Areas are important breeding areas for sage-grouse in Wyoming as identified by the Wyoming ''Governor's Sage-Grouse Implementation Team.'' In addition to identifying Core Population Areas, the Team also recommended stipulations that should be placed on development activities to ensure that existing habitat function is maintained within those areas. Accordingly, the executive order prescribes special consideration for sage-grouse, including authorization of new activities only when the project proponent can identify that the activity will not cause declines in greater sage-grouse populations, in the Core Population Areas. These protections will apply to slightly less than 23 percent of all sage-grouse habitats in Wyoming, but account for approximately 80 percent of the total estimated sage-grouse breeding population in the State. In February 2010, the Wyoming State Legislature adopted a joint resolution endorsing Wyoming's core area strategy as outlined in the Governor' Executive Order 2008-2.

On August 7, 2008, the Wyoming Board of Land Commissioners approved

the application of the Implementation Team's recommended stipulations to all new development activities on State lands within the Core Population Areas. These actions provide substantial regulatory protection for sage-grouse in previously undeveloped areas on Wyoming State lands. However, as they only apply to State lands, which are typically single sections scattered across the State, the benefit to sage-grouse is limited.

The executive order also applies to all activities requiring permits from the Wyoming's Industrial Siting Council (ISC), including wind power developments on all lands regardless of ownership in the State of Wyoming. Developments outside of State land and not required to receive an ISC permit (primarily developments that do not reach a certain economic threshold) will not be required to follow the stipulations. The application of the Governor's order to the Wyoming ISC has the potential to provide significant regulatory protection for sage-grouse from adverse effects associated with wind development (see Energy, Factor A) and other developments.

There is still some uncertainty regarding what protective stipulations will be applied to wind siting applications. The State of Wyoming has indicated that it will enforce the Executive Order where applicable, and on August 7, 2009, the Wyoming State Board of Land Commissioners voted to withdraw approximately 400,000 ha (approximately 1 million ac) of land within the sage-grouse core areas from potential wind development (State of Wyoming 2008, entire). The withdrawal order states that ''there is no published research on the specific impacts of wind energy on sage-grouse,'' and further states that permitting for wind development should require data collection on the potential effects of wind on sage-grouse. This action demonstrates a significant action in the State of Wyoming to address future development activities in core areas.

Wyoming's executive order does allow oil and gas leases on State lands within core areas, provided those developments adhere to required protective stipulations, which are consistent with published literature (e.g. 1 well pad per section). The Service believes that the core area strategy proposed by the State of Wyoming in Executive Order 2008-2, if implemented by all landowners via -regulatory mechanisms, would provide adequate protection for sage-grouse and their habitat in that State.

The protective measures associated with the Governor's order do not extend to lands located outside the identified core areas but still within occupied sage-grouse habitat. Where a siting permit is needed, the application is *de facto* applied to all landownerships as the Wyoming ISC cannot issue a permit without the protective stipulations in place. In non-core areas, the minimization measures would be implemented that are intended to maintain habitat conditions such that there is a 50 percent likelihood that leks will persist over time (WGFD 2009, pp. 30-35). This approach may result in adverse effects to sage-grouse and their habitats outside of the core areas (WGFD 2009, pp. 32-35).

The Wyoming executive order states that current management and existing land uses within the core areas should be recognized and respected, thus we anticipate ongoing adverse effects associated with those activities. The Service is working in collaboration with the State of Wyoming Sage Grouse Implementation team and other entities to continue to review and refine ongoing activities in the core areas, as well as the size and location of the core areas themselves to ensure the integrity and purpose of the core area approach is maintained. Although this strategy provides excellent potential for meaningful conservation of sage-grouse, it has yet to be fully implemented. We believe that when fully realized, this effort could ameliorate some threats to the greater sage-grouse.

On April 22, 2009, the Governor of Colorado signed into law new rules for the Colorado Oil and Gas Conservation Commission (COGCC), which is the entity responsible for permitting oil and gas well development in Colorado (COGCC 2009, entire). The rules went into effect on private lands on April 1, 2009, and on Federal lands July 1, 2009. The new rules require that permittees and operators determine whether their proposed development location overlaps with ''sensitive wildlife habitat,'' or is within restricted surface occupancy (RSO) Area. For greater sage-grouse, areas within 1 km (0.6 mi) of an active lek are designated as RSOs, and surface area occupancy will be avoided except in cases of economic or technical infeasibility (CDOW, 2009, p. 12). Areas within approximately 6.4 km (4 mi) of an active lek are considered sensitive wildlife habitat (CDOW, 2009, p. 13) and the development proponent is required to consult with the CDOW to identify measures to (1) avoid impacts on wildlife resources, including sage-grouse; (2) minimize the extent and severity of those impacts that cannot be avoided; and (3) mitigate those effects that cannot be avoided or minimized (COGCC 2009, section 1202.a).

The COGCC will consider CDOW's recommendations in the permitting decision, although the final permitting and conditioning authority remains with COGCC. Section 1202.d of the new rules does identify circumstances under which the consultation with CDOW is not required; other categories for potential exemptions also can be found in the new rules (e.g., 1203.b). The new rules will inevitably provide for greater consideration of the conservation needs of the species, but the potential decisions, actions, and exemptions can vary with each situation, and consequently there is substantial uncertainty as to the level of protection that will be afforded to greater sage-grouse. It should be noted that leases that have already been approved but not drilled (e.g., COGCC 2009, 1202.d(1)), or drilling operations that are already on the landscape, may continue to operate without further restriction into the future.

Some States require landowners to control noxious weeds, a habitat threat to sage-grouse on their property, but the types of plants considered to be noxious weeds vary by State. For example, only Oregon, California, Colorado, Utah, and Nevada list *Taeniatherum asperum* as a noxious, regulated weed, but *T. asperum* is problematic in other States (e.g., Washington, Idaho). Colorado is the only western State that officially lists *Bromus tectorum* as a noxious weed (USDA 2009), but *B. tectorum* is invasive in many more States. These laws may provide some protection for sage-grouse in areas, although large-scale control of the most problematic invasive plants is not occurring, and rehabilitation and restoration techniques are mostly unproven and experimental (Pyke in press, p. 25).

State-regulated hunting of sage-grouse is permitted in all States except Washington, where the season has been closed since 1988 (Connelly *et al*. 2004, p. 6-3). In States where hunting sage-grouse is allowed, harvest levels can be adjusted annually, and the season and limits are largely based on trend data gathered from spring lek counts and previous harvest data. Management of hunting season length and bag limits varies widely between States (see discussion of hunting regulations in Factor B). States maintain flexibility in hunting regulations through emergency closures or season changes in response to unexpected events that affect local populations. For example, in areas where populations are in decline or threats such as WNv have emerged, some States have implemented harvest

reductions or closures. There have not been any studies demonstrating that hunting is the primary cause of population declines in sage-grouse. Hunting regulations provide adequate protection for the birds (see discussion under Factor B), but do not protect the habitat. Therefore, the protection afforded through this regulatory mechanism is limited.

Federal Laws and Regulations

Because it is not considered to be a migratory species, the greater sage-grouse is not covered by the provisions of the Migratory Bird Treaty Act (16 U.S.C. 703-712). However, several Federal agencies have other legal authorities and requirements for managing sage-grouse or their habitat. Federal agencies are responsible for managing approximately 64 percent of the sagebrush habitats within the sage-grouse MZs in the United States (Knick in press, p. 39, Table 3). Two Federal agencies with the largest land management authority for sagebrush habitats are the BLM and USFS. The U.S. Department of Defense (DOD), DOE, and other agencies in DOI have responsibility for lands and/or decisions that involve less than 5 percent of greater sage-grouse habitat (Table 3).

Bureau of Land Management

Knick (in press, p. 39, Table 3) estimates that about 51 percent of sagebrush habitat within the sage-grouse MZs is BLM-administered land; this includes approximately 24.9 million ha (about 61.5 million ac). The Federal Land Policy and Management Act of 1976 (FLPMA) (43 U.S.C. 1701 *et seq.*) is the primary Federal law governing most land uses on BLM-administered lands, and directs development and implementation of Resource Management Plans (RMPs) which direct management at a local level. The greater sage-grouse is designated as a sensitive species on BLM lands across the species' range (Sell 2010, pers comm.). The management guidance afforded species of concern under BLM Manual 6840 – Special Status Species Management (BLM 2008f) states that ''Bureau sensitive species will be managed consistent with species and habitat management objectives in land use and implementation plans to promote their conservation and to minimize the likelihood and need for listing under the ESA'' (BLM 2008f, p. .05V). BLM Manual 6840 further requires that RMPs should address sensitive species, and that implementation ''should consider all site-specific methods and procedures needed to bring species and their habitats to the condition under which management under the Bureau sensitive species policies would no longer be necessary'' (BLM 2008f, p. 2A1). As a designated sensitive species under BLM Manual 6840, sage-grouse conservation must be addressed in the development and implementation of RMPs on BLM lands.

RMPs are the basis for all actions and authorizations involving BLM-administered lands and resources. They authorize and establish allowable resource uses, resource condition goals and objectives to be attained, program constraints, general management practices needed to attain the goals and objectives, general implementation sequences, intervals and standards for monitoring and evaluating RMPs to determine effectiveness, and the need for amendment or revision (43 CFR 1601.0-5(k)). The RMPs also provide a framework and programmatic direction for implementation plans, which are site-specific plans written to regulate decisions made in a RMP. Examples include allotment management plans (AMPs) that address livestock grazing, oil and gas field development, travel management, and wildlife habitat management. Implementation plan decisions normally require additional planning and NEPA analysis.

Of the existing 92 RMPs that include sage-grouse habitat, 82 contain specific measures or direction pertinent to management of sage-grouse or their habitats (BLM 2008g, p. 1). However, the nature of these measures and direction vary widely, with some measures directed at a particular land use category (e.g., grazing management), and others relevant to specific habitat use categories (e.g., breeding habitat) (BLM 2008h). If an RMP contains specific direction regarding sage-grouse habitat, conservation, or management, it represents a regulatory mechanism that has the potential to ensure that the species and its habitats are protected during permitting and other decision-making on BLM lands. This section describes our understanding of how RMPs are currently implemented in relation to sage-grouse conservation.

In addition to land use planning, BLM uses Instruction Memoranda (IM) to provide instruction to district and field offices regarding specific resource issues. Implementation of IMs is required unless the IM provides discretion (Buckner 2009a. comm.). However, IMs are short duration (1 to 2 years) and are intended to immediately address resource concerns or provide direction to staff until a threat passes or the resource issue can be addressed in a long-term planning document. Because of their short duration, their utility and certainty as a long-term regulatory mechanism may be limited if not regularly renewed.

The BLM IM No. 2005-024 directed BLM State directors to ''review all existing land use plans to determine the adequacy in addressing the threats to sage-grouse and sagebrush habitat,'' and then to ''identify and prioritize land use plan amendments or land use plan revisions based upon the outcome.'' This IM instructed BLM State directors to develop a process and schedule to update deficient land use plans to adequately address sage-grouse and sagebrush conservation needs no later than April 1, 2005. The BLM reports that all land use plan revisions within sage-grouse habitat are scheduled for completion by 2015 (BLM, 2008g). To date, 14 plans have been revised, 31 are in progress, and 19 are scheduled to be completed in the future. However, the information provided to us by BLM did not specify what requirements, direction, measures, or guidance has been included in the newly revised RMPs to address threats to sage-grouse and sagebrush habitat. Therefore, we cannot assess their value or rely on them as regulatory mechanisms for the conservation of the greater sage-grouse.

On November 30, 2009, the BLM in Montana issued an IM that provides guidance for sage-grouse management on lands under their authority in MZs I and II (BLM 2009j, entire). The IM directs all state offices in Montana to develop alternatives in ongoing and future RMP revisions for activities that may affect the greater sage-grouse. The IM provides guidance to mitigate impacts and BMPs for all proposed projects and activities. While this IM will result in reduction of negative impacts of projects authorized by the Montana BLM on sage-grouse, the way in which the guidance will be interpreted and applied is uncertain and we do not have a basis to assess whether or the extent to which it might be effective in reducing threats. However, the IM is based on an approach based on core areas in Montana, similar to the approach implemented more formally in Wyoming. Therefore, it could be effective in reducing impacts to sage-grouse habitat in the short term on BLM lands in Montana. Unfortunately, the IM applies only to ongoing and future RMPs, and does not apply to activities authorized under existing RMPs. No expiration date was provided for this IM, but as discussed above typical life expectancy of IMs is rarely greater than 2 years.

The BLM has regulatory authority over livestock grazing, OHV travel and

human disturbance, infrastructure development, fire management, and energy development through FLPMA and associated RMP implementation, and the Mineral Leasing Act (MLA) (30 U.S.C. 181 *et seq.*). The RMPs provide a framework and programmatic guidance for AMPs that address livestock grazing. In addition to FLPMA, BLM has specific regulatory authority for grazing management provided at 43 CFR 4100 (Regulations on Grazing Administration Exclusive of Alaska). Livestock grazing permits and leases contain terms and conditions determined by BLM to be appropriate to achieve management and resource condition objectives on the public lands and other lands administered by the BLM, and to ensure that habitats are, or are making significant progress toward being restored or maintained for BLM special status species (43 CFR 4180.1(d)). Terms and conditions that are attached to grazing permits are generally mandatory. Across the range of sage-grouse, BLM required each BLM state office to adopt rangeland health standards and guidelines by which they measure allotment condition (43 CFR 4180 2(b)). Each state office developed and adopted their own standards and guidelines based on habitat type and other more localized considerations.

The rangeland health standards must address restoring, maintaining or enhancing habitats of BLM special status species to promote their conservation, and maintaining or promoting the physical and biological conditions to sustain native populations and communities (43 CFR 4180.2(e)(9) and (10)). BLM is required to take appropriate action no later than the start of the next grazing year upon determining that existing grazing practices or levels of grazing use are significant factors in failing to achieve the standards and conform with the guidelines (43 CFR 4180.2(c)).

The BLM conducted national data calls in 2004 through 2008 to collect information on the status of rangelands, rangeland health assessments, and measures that have been implemented to address rangeland health issues across sage-grouse habitats under their jurisdiction. However, the information collected by BLM could not be used to make broad generalizations about the status of rangelands and management actions. There was a lack of consistency across the range in how questions were interpreted and answered for the data call, which limited our ability to use the results to understand habitat conditions for sage-grouse on BLM lands. For example, one question asked about the number of acres of land within sage-grouse habitat that was meeting rangeland health standards. Field offices in more than three States conducted the rangeland health assessments, and reported landscape conditions at different scales (Sell 2009, pers. comm.). In addition, the BLM data call reported information at a different scale than was used for their landscape mapping (District or project level versus national scale) (Buckner 2009b, pers. comm.). Therefore, we lack the information necessary to assess how this regulatory mechanism effects sage-grouse conservation.

The BLM's regulations require that corrective action be taken to improve rangeland condition when the need is identified; however, actions are not necessarily implemented until the permit renewal process is initiated for the noncompliant parcel. Thus, there may be a lag time between the allotment assessment when necessary management changes are identified, and when they are implemented. Although RMPs, AMPs, and the permit renewal process provide an adequate regulatory framework, whether or not these regulatory mechanisms are being implemented in a manner that conserves sage-grouse is unclear. The BLM's data call indicates that there are lands within the range of sage-grouse that are not meeting the rangeland health standards necessary to conserve sage-grouse habitats. In some cases management changes should occur, but such changes have not been implemented (BLM 2008i).

The BLM uses regulatory mechanisms to address invasive species concerns, particularly through the NEPA process. For projects proposed on BLM lands, BLM has the authority to identify and prescribe best management practices for weed management; where prescribed, these measures must be incorporated into project design and implementation. Some common best management practices for weed management may include surveying for noxious weeds, identifying problem areas, training contractors regarding noxious weed management and identification, providing cleaning stations for equipment, limiting off-road travel, and reclaiming disturbed lands immediately following ground disturbing activities, among other practices. The effectiveness of these measures is not documented.

The BLM conducts treatments for noxious and invasive weeds on BLM lands, the most common being reseeding through the Emergency Stabilization and Burned Area Rehabilitation Programs. According to BLM data, 66 of 92 RMPs noted that seed mix requirements (as stated in RMPs, emergency stabilization and rehabilitation, and other plans) were sufficient to provide suitable sage-grouse habitat (e.g., seed containing sagebrush and forb species)(Carlson 2008a). However, a sufficient seed mix does not assure that restoration goals will be met; many other factors (e.g., precipitation) influence the outcome of restoration efforts.

Invasive species control is a priority in many RMPs. For example, 76 of the RMPs identified in the data call claim that the RMP (or supplemental plans/ guidance applicable to the RMP) requires treatment of noxious weeds on all disturbed surfaces to avoid weed infestations on BLM managed lands in the planning area (Carlson 2008a). Also, of the 82 RMPs that reference sage-grouse conservation, 51 of these specifically address fire, invasives, conifer encroachment, or a combination thereof (Carlson 2008, pers. comm.). We note that it is possible that more RMPs are addressing invasives under another general restoration category. In the 51 RMPs that address fire, invasives, and conifer encroachment, they typically provide nonspecific guidance on how to manage invasives. A few examples include: manage livestock in a way that enhances desirable vegetation cover and reduces the introduction of invasives, identify tools that may be used to control invasives (e.g., manual, mechanical, biological, or chemical treatments), utilize an integrated weed management program, and apply seasonal restrictions on fire hazards, among other methods (Carlson 2008, pers. comm.). As with other agencies and organizations, the extent to which these measures are implemented depends in large part on funding, staff time, and other regulatory and non-regulatory factors. Therefore, we cannot assess their value as regulatory mechanisms for the conservation of the greater sage-grouse.

Herbicides also are commonly used on BLM lands to control invasives. In 2007, the BLM completed a programmatic EIS (72 FR 35718) and record of decision (72 FR 57065) for vegetation treatments on BLM-administered lands in the western United States. This program guides the use of herbicides for field-level planning, but does not authorize any specific on-the-ground actions; site-specific NEPA analysis is still required at the project level.

The BLM has one documented regulatory action to address wildfire and protect of sage-grouse: National IM 2008-142 – 2008 Wildfire Season and Sage-Grouse Conservation. This IM was issued on June 19, 2008, and was

effective through September 30, 2009. It provided guidance to BLM State directors that conservation of greater sage-grouse and sagebrush habitats should be a priority for wildfire suppression, particularly in areas of the Great Basin (portions of WAFWA MZ III, IV, and V) (BLM 2008j, entire). At least one BLM State office within the range of sage-grouse (Idaho) developed a State-level IM and guidance that prioritized the protection of sage-grouse habitats during fire management activities, in addition to the national IM which pertains to wildfire suppression activities (BLM 2008k, entire).

While we do not know the extent to which these directives alleviated the wildfire threat to sage-grouse (as described under Factor A) during the 2008 and 2009 fire seasons, we believe that this strategic approach to ameliorating the threat of fire is appropriate and significant. Targeting the protection of important sage-grouse habitats during fire suppression and fuels management activities could help reduce loss of key habitat due to fire if directed through a long-term, regulatory mechanism. Under Factor A, we describe why the threat of wildfire is likely to continue indefinitely. This foreseeable future requires a regulatory approach that addresses the threat over the long term. The use of IMs to increase protection of sage-grouse habitat during wildfire is not adequate to protect the species because IMs are both short-term and have discretionary renewal (decisions made on a case-by-case basis).

The BLM is the primary Federal agency managing the United States energy resources on 102 million surface ha (253 million ac) and 283 million sub-surface ha (700 million ac) of mineral estate (BLM 2010). Public sub-surface estate can be under public or private (i.e., split-estate) surface. Over 7.3 million ha (18 million ac) of sage-grouse habitats on public lands are leased for oil, gas, coal, minerals, or geothermal exploration and development across the sage-grouse range (Service 2008f). Energy development, particularly nonrenewable development, has primarily occurred within sage-grouse MZs I and II.

The BLM has the legal authority to regulate and condition oil and gas leases and permits under both FLPMA and the MLA. An amendment to the Energy Policy and Conservation Act of 1975 (42 U.S.C. 6201 *et seq.*) in 2000 (Energy Policy Act of 2000 (PL 106-469)) requires the Secretary of the Interior to conduct a scientific inventory of all onshore Federal lands to identify oil and gas resources underlying these lands (42 U.S.C. 6217). The Energy Policy Act of 2005 (42 U.S.C. 15801 *et seq.*) further requires the nature and extent of any restrictions or impediments to the development of such resources be identified and permitting and development be expedited on Federal lands (42 U.S.C. 15921). In addition, the 2005 Energy Policy Act orders the identification of renewable energy sources (e.g., wind, geothermal) and provides incentives for their development (42 U.S.C. 15851).

On May 18, 2001, President Bush signed Executive Order (E.O.) 13212 – Actions to Expedite Energy-Related Projects (May 22, 2001, 66 FR 28357), which states that the executive departments and agencies shall take appropriate actions, to the extent consistent with applicable law, to expedite projects that will increase the production, transmission, or conservation of energy. The Executive Order specifies that this includes expediting review of permits or taking other actions as necessary to accelerate the completion of projects, while maintaining safety, public health, and environmental protections. On October 23, 2009, nine Federal agencies signed a MOU to expedite the siting and construction of qualified electric transmission within the United States (Federal Agency MOU 2009). The MOU states that all existing environmental review and safeguard processes will be fully maintained. Therefore, we assume that this new MOU will not alter the regulatory processes (e.g., RMPs, project specific NEPA analysis) currently in place related to transmission siting on BLM lands.

Program-specific guidance for fluid minerals (including oil and gas) in the BLM planning handbook (BLM 2005b, Appendix C pp. 23-24) specifies that land use planning decisions will identify restrictions on areas subject to leasing, including closures, as well as lease stipulations. Stipulations are conditions that are made part of a lease when the environmental planning record demonstrates the need to accommodate various resources such as the protection of specific wildlife species. Stipulations advise the lease holder that a wildlife species in need of special management may be present in the area defined by the lease, and certain protective measures may be required in order to develop the mineral resource on that lease.

The handbook further specifies that all stipulations must have waiver, exception, or modification criteria documented in the plan, and notes that the least restrictive constraint to meet the resource protection objective should be used (BLM 2005b, Appendix C pp. 23-24). Waivers are permanent exemptions, and modifications are changes in the terms of the stipulation. The BLM reports the issuance of waivers and modifications as rare (BLM 2008i). Exceptions are a one-time exemption to a lease stipulation. For example, a company may be issued an exception to enter crucial winter habitat during a mild winter if an on-the-ground survey verifies that sage-grouse are not using the winter habitat or have left earlier than normal (BLM 2004, p. 86). In 2006 and 2007, of 1,716 mineral or right-of-way authorizations on Federal surface in 42 BLM planning areas no waivers were issued; 24 modifications were issued and 115 exceptions were granted, 72 of which were in the Great Divide planning area in Wyoming (BLM 2008i), one of the densest population concentrations for sage-grouse.

Although the restrictive stipulations that are applied to permits and leases vary, a 0.40-km (0.25-mi) radius around sage-grouse leks is generally restricted to ''no surface occupancy'' during the breeding season, and noise and development activities are often limited during the breeding season within a 0.80- to 3.22-km (0.5- to 2-mi) radius of sage-grouse leks. Although these are the most often-applied stipulations, site-specific application is highly variable. For example, language in the Randolph RMP in Utah states that no exploration, drilling, or other development activities can occur during the breeding season within 3.22 km (2 mi) of a known sage-grouse lek, and that there are ''no exceptions to this stipulation'' (BLM 2008h). Conversely, under the Platte River RMP in the Wind River Basin Management Area of Wyoming, ''oil and gas development is a priority in the area'' and ''discretionary timing stipulations protecting sage-grouse nesting habitats...will not be applied'' (BLM 2008h). Most of the RMPs that address oil, gas, or minerals development specify the standard protective stipulations (BLM 2008h). The stipulations do not apply to the operation or maintenance of existing facilities, regardless of their proximity to sage-grouse breeding areas (BLM 2008h). In addition, approximately 73 percent of leased lands in known sage-grouse breeding habitat have no stipulations at all (Service 2008f).

As noted above, a 0.4-km (0.25-mi) radius buffer is used routinely by BLM and other agencies to minimize the impacts of oil and gas development on sage-grouse breeding activity. The rationale for using a 0.4-km (0.25-mi) buffer as the basic unit for active lek

protection is not clear, as there is no support in published literature for this distance affording any measure of protection (see also discussion under Energy Development, above). Anecdotally, this distance appears to be an artifact from the 1960s attempt to initiate planning guidelines for sagebrush management and is not scientifically based (Roberts 1991). The BLM stipulations most commonly attached to leases and permits are inadequate for the protection of sage-grouse, and for the long-term maintenance of their populations in those areas affected by oil and gas development activities (Holloran 2005, pp. 57-60; Walker 2007, p. 2651). In some locations, the BLM is incorporating recommendations and information from new scientific studies into management direction. Wyoming BLM issued an IM on December 29, 2009 (BLM 2009k, entire) to ensure their management of sage-grouse and their habitats are consistent with the State of Wyoming's core area populations (see discussion above). The IM applies to all BLM programs and activities within Wyoming, with the exception of livestock grazing management. A separate IM will be issued separately for this program. The December 2009 IM should have the same efficacy in ameliorating threats to the sage-grouse in Wyoming. However, the IM is scheduled to expire on Sept. 30, 2011, and therefore its life is far shorter than the foreseeable future (30 to 50 years, see discussion below) for energy development in that state. However, we are optimistic that this IM will result in short-term conservation benefits for sage-grouse in Wyoming.

As with fossil fuel sources, the production, purchase, and facilitation of development of renewable energy products by Federal entities and land management agencies is directed by the 2005 Energy Policy Act and Presidential E.O. 13212. The energy development section of Factor A describes in detail the development and operation of renewable energy projects, including recent increases in wind, solar and geothermal energy development. All of these activities require ground disturbance, infrastructure, and ongoing human activities that could adversely affect greater sage-grouse on the landscape. Recently the BLM has begun developing guidance to minimize impacts of renewable energy production on public lands. A ROD for ''Implementation of a Wind Energy Development Program and Associated Land Use Plan Amendments'' (BLM 2005a, entire) was issued in 2005. The ROD outlines best management practices (BMPs) for the siting, development and operation of wind energy facilities on BLM lands. The voluntary guidance of the BMPs do not include measures specifically intended to protect greater sage-grouse, although they do provide the flexibility for such measures to be required through site-specific planning and authorization (BLM 2005a, p. 2).

On December 19, 2008, the BLM issued IM 2009-043, which is intended to serve as additional guidance for processing wind development proposals. In that IM, which expires on September 30, 2010, BLM updates or clarifies previous guidance documentation, including the Wind Energy Development Policy, and best management practices from the wind energy development programmatic EIS of 2005. The new guidance does not provide specific recommendations for greater sage-grouse, and largely defers decision-making regarding project siting, including meteorological towers, to either the individual land use planning process, or to the standard environmental compliance (i.e., NEPA) process. In addition, it emphasizes the voluntary nature of the Service's 2003 interim guidelines for minimizing the effects of wind turbines on avian species and reiterates that incorporation of the guidelines in BLM agency decisions was not mandatory (BLM 2008e).

BLM State offices in Oregon and Idaho issued explicit guidance regarding siting of meteorological towers (IM OR-2008-014 and ID-2009-006, respectively) which required siting restrictions for towers around leks such that potential adverse effects to sage-grouse are avoided or minimized. These IMs provided substantial regulatory protection for sage-grouse; however, both of these IMs expired on September 30, 2009. We anticipate that they will be renewed in FY 2010, but that is an annual management decision by the respective State BLM offices, thus the long-term certainty that such measures will remain in place is unknown.

The BLM is currently in the process of developing programmatic-level guidance for the development of solar and geothermal energy projects. A draft programmatic EIS for geothermal development is currently available (BLM and USFS 2008a, entire), and the draft programmatic EIS for solar energy is under development (BLM and DOE 2008). We anticipate that solar and geothermal energy development will increase in the future (see discussion under energy in Factor A), and that the development of infrastructure associated with these projects could affect sage-grouse. Final environmental guidance for solar and geothermal energy development on BLM lands has not yet been issued or implemented; thus, we cannot assess its adequacy or implications for the conservation of sage-grouse.

Summary: BLM

The BLM manages the majority of greater sage-grouse habitats across the range of the species. The BLM has broad regulatory authority to plan and manage all land use activities on their lands including travel management, energy development, grazing, fire management, invasive species management, and a variety of other activities. As described in Factor A, all of these factors have the potential to affect sage-grouse, including direct effects to the species and its habitats. The ability of regulatory mechanisms to adequately address the effects associated with wildfire or invasive plant species such as *Bromus tectorum* is limited due primarily to the nature of those factors and how they manifest on the landscape. However, a regulatory mechanism that requires BLM staff to target the protection of key sage-grouse habitats during fire suppression or appropriate fuels management activities could help address the threat of wildfire in some situations. We recognize the use of IMs for this purpose, including both at the national and State level (Idaho) (BLM 2008j and 2008k); however, a long-term mechanism is necessary given the scale of the wildfire threat and its likelihood to persist on the landscape in the foreseeable future.

For other threats to sage-grouse on BLM lands, the BLM has the regulatory authority to address them in a manner that will provide protection for sage-grouse. However, BLM's current application of those authorities in some areas falls short of meeting the conservation needs of the species. This is particularly evident in the regulation of oil, gas, and other energy development activities, both on BLM-administered lands and on split-estate lands. Stipulations commonly applied by BLM to oil and gas leases and permits do not adequately address the scope of negative influences of development on sage-grouse (Holloran 2005, pp. 57-60, Walker 2007, pp. 2651; see discussion under Factor A), with the exception of the new 2010 IM issued by the BLM in Wyoming (see discussion below). In addition, BLM's ability to waive, modify, and allow exceptions to those stipulations without regard to sage-grouse persistence further limits the adequacy of those regulatory mechanisms in alleviating the negative

impacts to the species associated with energy development.

For other threats, such as grazing, our ability to assess the application of existing regulatory mechanisms on a broad scale is limited by the way that BLM collected and summarized their data on rangeland health assessments and the implementation of corrective measures, where necessary. The land use planning and activity permitting processes, as well as other regulations available to BLM give them the authority to address the needs of sage-grouse. However, the extent to which they do so varies widely from RMP area to RMP area across the range of the species. In many areas existing mechanisms (or their implementation) on BLM lands and BLM-permitted actions do not adequately address the conservation needs of greater sage-grouse, and are exacerbating the effects of threats to the species described under Factor A.

USDA Forest Service

The USFS has management authority for 8 percent of the sagebrush area within the sage-grouse MZs (Table 3; Knick in press, p. 39). The USFS estimated that sage-grouse occupy about 5.2 million ha (12.8 million ac) on national forest lands in the western United States (USFS 2008 Appendix 2, Table 1). Twenty-six of the 33 National Forests or Grasslands across the range of sage-grouse contain moderately or highly important seasonal habitat for sage-grouse (USFS 2008 Appendix 2, Table 2). Management of activities on national forest system lands is guided principally by the National Forest Management Act (NFMA) (16 U.S.C. 1600-1614, August 17, 1974, as amended 1976, 1978, 1980, 1981, 1983, 1985, 1988, and 1990). NFMA specifies that the USFS must have a land and resource management plan (LRMP) (16 U.S.C. 1600) to guide and set standards for all natural resource management activities on each National Forest or National Grassland. All of the LRMPs that currently guide the management of sage-grouse habitats on USFS lands were developed using the 1982 implementing regulations for land and resource management planning (1982 Rule, 36 CFR 219).

Greater sage-grouse is designated as sensitive species on USFS lands across the range of the species (USFS 2008, pp. 25-26). Designated sensitive species require special consideration during land use planning and activity implementation to ensure the viability of the species on USFS lands and to preclude any population declines that could lead to a Federal listing (USFS 2008, p. 21). Additionally, sensitive species designations require analysis for any activity that could have an adverse impact to the species, including analysis of the significance of any adverse impacts on the species, its habitat, and overall population viability (USFS 2008, p. 21). The specifics of how sensitive species status has conferred protection to sage-grouse on USFS lands varies significantly across the range, and is largely dependent on LRMPs and site-specific project analysis and implementation. Fourteen forests identify greater sage-grouse as a Management Indicator Species (USFS 2008, Appendix 2, Table 2), which requires them to establish objectives for the maintenance and improvement of habitat for the species during all planning processes, to the degree consistent with overall multiple use objectives of the alternative (1982 Rule, 36 CFR 219.19(a)). Of the 33 National Forests that manage greater sage-grouse habitat, 16 do not specifically address sage-grouse management or conservation in their Forest Plans, and only 6 provide a high level of detail specific to sage-grouse management (USFS 2008, Appendix 2, Table 4).

Almost all of the habitats that support sage-grouse on USFS lands also are open to livestock grazing (USFS 2008, p. 39). Under the Range Rescissions Act of 1995 (P.L. 104-19), the USFS must conduct a NEPA analysis to determine whether grazing should be authorized on an allotment, and what resource protection provisions should be included as part of the authorization (USFS 2008, p. 33). The USFS reports that they use the sage-grouse habitat guidelines developed in Connelly *et al.* (2000) to develop desired condition and livestock use standards at the project or allotment level. However, USFS also reported that the degree to which the recommended sage-grouse conservation and management guidelines were incorporated and implemented under Forest Plans varied widely across the range (USFS 2008, p. 45). We do not have the results of rangeland health assessments or other information regarding the status of USFS lands that provide habitat to sage-grouse and, therefore, cannot assess the efficacy in conserving this species.

Energy development occurs on USFS lands, although to a lesser extent than on BLM lands. Through NFMA, LRMPs, and the On-Shore Oil and Gas Leasing Reform Act (1987; implementing regulations at 36 CFR 228, subpart E), the USFS has the authority to manage, restrict, or attach protective measures to mineral and other energy permits on USFS lands. Similar to BLM, existing protective standard stipulations on USFS lands include avoiding construction of new wells and facilities within 0.4 km (0.25 mi), and noise or activity disturbance within 3.2 km (2.0 mi) of active sage-grouse leks during the breeding season. As described both in Factor A and above, this buffer is inadequate to prevent adverse impacts to sage-grouse populations. For most LRMPs where energy development is occurring, these stipulations also apply to hard mineral extraction, wind development, and other energy development activities in addition to fluid mineral extraction (USFS 2008, Appendix 1, entire). The USFS is a partner agency with the BLM on the draft programmatic EIS for geothermal energy development described above. The Record of Decision for the EIS does not amend relevant LRMPs and still requires project-specific NEPA analysis of geothermal energy applications on USFS lands (BLM and USFS 2008b, p. 3).

The land use planning process and other regulations available to the USFS give it the authority to adequately address the needs of sage-grouse, although the extent to which they do so varies widely across the range of the species. We do not have information regarding the current land health status of USFS lands in relation to the conservation needs of greater sage-grouse; thus, we cannot assess whether existing conditions adequately meet the species' habitat needs.

Other Federal Agencies

Other Federal agencies in the DOD, DOE, and DOI (including the Bureau of Indian Affairs, the Service, and National Park Service) are responsible for managing less than 5 percent of sagebrush lands within the United States (Knick 2008, p. 31). Regulatory authorities and mechanisms relevant to these agencies' management jurisdictions include the National Park Service Organic Act (39 Stat. 535; 16 U.S.C. 1, 2, 3 and 4), the National Wildlife Refuge System Administration Act (16 U.S.C. 668dd-668ee), and the Department of the Army's Integrated Natural Resources Management Plans for their facilities within sage-grouse habitats. Due to the limited amount of land administered by these agencies, we have not described them in detail here. However, most of these agencies do not manage specifically for greater sage-grouse on their lands, except in localized areas (e.g., specific wildlife refuges, reservations). One exception is DOD regulatory mechanisms applicable within MZ VI, where half of the

remaining sage-grouse populations and habitats occur on their lands.

The Yakima Training Center (YTC), a U.S. Army facility, manages land in Washington that is the primary habitat for one of two populations of greater sage-grouse in that State. During the breeding season, the YTC has restrictions on training activities for the protection of sage-grouse. Leks have a 1-km (0.6-mi) buffer where all training is excluded, and aircraft below 91.4 m (300 ft) are restricted from midnight to 9 am from March 1 to May 15 (Stinson *et al.* 2004, p. 32). Sage-grouse protection areas also are identified, and training activities are restricted in those areas during nesting and early brood rearing periods (Stinson *et al.* 2004, p. 32). Other protections also are provided. According to Stinson *et al.* (2004, p. 32), the ''YTC is the only area in Washington where sage-grouse are officially protected from disturbance during the breeding and brood-rearing period.'' However, the biggest concern for sage-grouse on the YTC is wildfire, both natural and human-caused (Schroeder 2009, pers. comm.). Military training activities occur across the YTC throughout the year, including when there is high fire risk, and many fires are started every year (Schroeder 2009, pers. comm.). Although the YTC has an active fire response program, there are some fires most years that grow large, and habitat is being burned faster than it can be replaced (Schroeder 2009, pers. comm.). The protective stipulations to reduce disturbance to greater sage-grouse are useful; however, current management, training activities, and fire response, are resulting in habitat loss for the species on the YTC.

The USDA Farm Service Agency manages the Conservation Reserve Program (CRP) which pays landowners a rental fee to plant permanent vegetation on portions of their lands, taking them out of agricultural production (Schroeder and Vander Haegen in press, p. 4-5). These lands are put under contract, typically for a 10–year period (Walker 2009, pers. comm.). In some areas across the range of sage-grouse, and particularly in Washington (Schroeder and Vander Haegen in press, p. 21), CRP lands provide important habitat for the species (see Factor A discussion). Under the 2008 Farm Bill, several changes could reduce the protection that CRP lands afford sage-grouse. First, the total acreage that can be enrolled in the CRP program at any time has been reduced from 15.9 million ha (39.2 million ac) to 12.9 million ha (32 million ac) for 2010-2012 (USDA 2009a, p. 1). Second, no more than 25 percent of the agricultural lands in any county can now be enrolled under CRP contracts, although there are provisions to avoid this cap if permission is granted by the County government (Walker 2009, pers. comm.). Third, the 2008 Farm Bill authorized the BCAP, which provides financial assistance to agricultural producers to establish and produce eligible crops for the conversion to bioenergy products (USDA 2009b, p. 1). As CRP contracts expire, the BCAP program could result in greater incentives to take land out of CRP and put it into production for biofuels (Walker 2009, pers. comm.). All of these changes could affect the amount of land in CRP, and in turn the habitat value provided to greater sage-grouse. This change is of particular importance in Washington, where CRP lands have been out of production long enough to provide habitat for sage-grouse. Although the 2008 Farm Bill has been signed into law, the implementing regulations and rules have not yet been finalized. Thus, we cannot assess how the measures described above will be implemented, and to what extent they may change the quantity or quality of CRP land available for sage-grouse.

Canadian Federal and Provincial Laws and Regulations

Greater sage-grouse are federally protected in Canada as an endangered species under schedule 1 of the Species at Risk Act (SARA; Canada Gazette, Part III, Chapter 29, Volume 25, No. 3, 2002). Passed in 2002, SARA is similar to the ESA and allows for habitat regulations to protect sage-grouse (Aldridge and Brigham 2003, p. 31). The species is also listed as endangered at the provincial level in Alberta and Saskatchewan, and neither province allows harvest (Aldridge and Brigham 2003, p. 31). In Saskatchewan, sage-grouse are protected under the Wildlife Habitat Protection Act, which protects sage-grouse habitat from being sold or cultivated (Aldridge and Brigham 2003, p. 32). In addition, sage-grouse are listed as endangered under the Saskatchewan Wildlife Act, which restricts development within 500 m (1,640 ft) of leks and prohibits construction within 1,000 m (3,281 ft) of leks between March 15 and May 15 (Aldridge and Brigham 2003, p. 32). As stated above, these buffers are inadequate to protect sage-grouse from disturbance. In Alberta, individual birds are protected, but their habitat is not (Aldridge and Brigham 2003, p. 32). Thus, although there are some protections for the species in Canada, they are not sufficient to assure conservation of the species.

Nonregulatory Conservation Measures

There are many non-regulatory conservation measures that may provide local habitat protections. Although they are non-regulatory in nature, they are here to acknowledge these programs. We have reviewed and taken into account efforts being made to protect the species, as required by the Act. Although some local conservation efforts have been implemented and are effective in small areas, they are neither individually nor collectively at a scale that is sufficient to ameliorate threats to the species or populations. Many other conservation efforts are being planned but there is substantial uncertainty as to whether, where, and when they will be implemented, and whether they will be effective; further, even if the efforts being planned or considered become implemented and are effective in the future, they are not a scale, either individually or collectively, to be sufficient to ameliorate the threats to the species.

Other partnerships and agencies have also implemented broader-scale conservation efforts. Cooperative Weed Management Areas (CWMAs) provide a voluntary approach to control invasive species across the range of sage-grouse. CWMAs are partnerships between Federal, State, and local agencies, tribes, individuals, and interested groups to manage both species designated by State agencies as noxious weeds, and invasive plants in a county or multi-county geographical area. As of 2005, Oregon, Nevada, Utah, and Colorado had between 75 and 89 percent of their States covered by CWMAs or county weed districts, while Washington, Idaho, Montana, and Wyoming had between 90 and 100 percent coverage. Coverage in North Dakota is between 50 and 74 percent, and South Dakota has less than 25 percent coverage (Center for Invasive Plant Management 2008). Because these CWMAs are voluntary partnerships we cannot be assured that they will be implemented nor can we predict their effectiveness.

The Natural Resources Conservation Service (NRCS) of the USDA provides farmers, ranchers, and other private landowners with technical assistance and financial resources to support various management and habitat restoration efforts. This includes helping farmers and ranchers maintain and improve wildlife habitat as part of larger management efforts, and developing technical information to assist NRCS field staff with sage-grouse considerations when working with private landowners. Because of the variable nature of the actions that can be

taken and the species they may address, some may benefit greater sage-grouse, some may cause negative impacts (e.g., because they are aimed at creating habitat conditions for other species that are inconsistent with the needs of sage-grouse), or are neutral in their effects. In May 2008, Congress passed the Food, Conservation, and Energy Act of 2008 (2008 Farm Bill, P.L. 110-246). The Farm Bill maintains or extends various technical and funding support programs for landowners. All conservation programs under the Farm Bill are voluntary, unless binding contracts for conservation planning or restoration are completed.

In 2006, WAFWA published the ''Greater Sage-Grouse Comprehensive Conservation Strategy'' (Conservation Strategy; Stiver *et al.* 2006). This document describes a range-wide framework to ''maintain and enhance populations and distribution of sage-grouse'' (Stiver *et al.* 2006, p. ES-1). Although this framework is important to guiding successful long-term conservation efforts and management of the greater sage-grouse and its habitats, by design the WAFWA Conservation Strategy is not regulatory in nature. Implementation of recommendations in the Strategy by each signatory to the associated MOU is voluntary and few, if any of the conservation recommendations have been implemented. Given the lack of funding for this effort, we do not have the assurances that implementation will occur. However, this is the most comprehensive inter-agency strategy developed for this species and therefore, if the principles identified are properly implemented it could have significant positive impacts.

All of the States in the extant range of the greater sage-grouse have finalized conservation or management plans for the species and its habitats. These plans focus on habitat and population concerns at a State level. The degree to which they consider and address mitigation for a variety of threats varies substantially. For example, some plans propose explicit strategies for minerals and energy issues (e.g., Montana) or wind energy development (e.g., Washington), and others more generally acknowledge potential issues with energy development but do not identify specific conservation measures (e.g., Nevada) (Stiver *et al.* 2006, p. 2-24). These plans are in various stages of implementation. The State level plans are not prescriptive, and generally contain information to help guide the development and implementation of more focused conservation efforts and planning at a local level. We recognize the importance of these plans and coordination efforts, but at this time cannot rely on them being effectively implemented. Specific measures recommended in a State plan that have been adopted into legal or regulatory frameworks (e.g., a resource management plan), are assessed as regulatory mechanisms in the discussion under Factor D.

The WDFW has designated sage-grouse habitat as a ''priority habitat'' which classifies it as a priority for conservation and management, and provides species and habitat information to interested parties for land use planning purposes (Schroeder *et al.* 2003, pp. 17-4 to 17-6, Stinson *et al.* 2004, p. 31). However, the recommendations provided under this program are guidelines, and we cannot be assured they will be implemented. Similarly, programs like Utah's Watersheds Restoration Initiative are partnership driven efforts intended to conserve, manage, and restore habitats. We recognize projects and cooperative efforts that are beneficial for sage-grouse may occur as a result of this program.

Summary of Nonregulatory Conservation Efforts

There are several non-regulatory conservation efforts that address impacts to the sage-grouse, mostly at a local scale (e.g. local working group plans, CCAA). Their voluntary nature is appreciated, but their implementation and effectiveness may be compromised as a result. We are encouraged by the number and scale of these efforts, but lacking data on exact locations, scale, and effectiveness, we do not know if threats to the greater sage-grouse will be ameliorated as a result. We strongly encourage implementation of the WAFWA Conservation Strategy as we believe its implementation could be effective in reducing threats to this species.

Summary of Factor D

To our knowledge, no current local land use or development planning regulations provide adequate protection to sage-grouse from development or other harmful land uses. Development and fragmentation of private lands is a threat to greater sage-grouse (see discussion under Factor A), and current local regulations do not adequately address this threat.

Wyoming and Colorado have implemented State regulations regarding energy development that could provide significant protection for greater sage-grouse. In Wyoming, regulations regarding new energy development have the potential to provide adequate protection to greater sage-grouse by protecting core areas of the species' habitat. BLM Wyoming has adopted Wyoming's approach for projects under their authorities through a short-term IM. However, the restrictive regulations do not apply to existing leases, or to habitats outside of core areas. Thus, sage-grouse may continue to experience population-level impacts associated with activities (e.g., energy development) in Wyoming (see discussion under Factor A) both inside and outside core areas. In Colorado, the regulations describe a required process rather than a specific measure that can be evaluated; the regulations are only recently in place and their implementation and effectiveness remains to be seen.

The majority of sage-grouse habitat in the United States is managed by Federal agencies (Table 3). The BLM and USFS have the legal authority to regulate land use activities on their respective lands. Under Factor A, we describe the ways that oil, natural gas, and other energy development activities, fire, invasive species, grazing, and human disturbance are or may be adversely affecting sage-grouse populations and habitat. Overall, Federal agencies' abilities to adequately address the issues of wildfire and invasive species across the landscape, and particularly in the Great Basin, are limited. However, we believe that new mechanisms could be adopted to target the protection of sage-grouse habitats during wildfire suppression activities or fuels management projects, which could help reduce this threat in some situations. There is limited opportunity to implement and apply new regulatory mechanisms that would provide adequate protections or amelioration for the threat of invasive species. For grazing, the regulatory mechanisms available to the BLM and USFS are adequate to protect sage-grouse habitats; however, the application of these mechanisms varies widely across the landscape. In some areas, rangelands are not meeting the habitat standards necessary for sage-grouse, and that contributes to threats to the species.

Our assessment of the implementation of regulations and associated stipulations guiding energy development indicates that current measures do not adequately ameliorate impacts to sage-grouse. Energy and associated infrastructure development, including both nonrenewable and renewable energy resources, are expected to continue to expand in the foreseeable future. Unless protective measures consistent with new research findings are widely implemented via a regulatory process, those measures

cannot be considered an adequate regulatory mechanism in the context of our review. For the BLM and USFS, RMPs and LRMPs are mechanisms through which adequate protections for greater sage-grouse could be implemented. However, the extent to which appropriate measures to conserve sage-grouse have been incorporated into those planning documents, or are being implemented, varies across the range. As evidenced by the discussion above, and the ongoing threats described under Factor A, BLM and the USFS are not fully implementing the regulatory mechanisms available to conserve greater sage-grouse on their lands.

Based on our review of the best scientific and commercial information available, we conclude that existing regulatory mechanisms are inadequate to protect the species. The absence of adequate regulatory mechanisms is a significant threat to the species, now and in the foreseeable future.

Factor E: Other Natural or Manmade Factors Affecting the Species' Continued Existence.

Pesticides

Few studies have examined the effects of pesticides to sage-grouse, but at least two have documented direct mortality of greater sage-grouse from use of these chemicals. Greater sage-grouse died as a result of ingestion of alfalfa sprayed with organophosphorus insecticides (Blus *et al*. 1989, p. 1142; Blus and Connelly 1998, p. 23). In this case, a field of alfalfa was sprayed with methamidophos and dimethoate when approximately 200 sage-grouse were present; 63 of these sage-grouse were later found dead, presumably as a result of pesticide exposure (Blus *et al*. 1989; p. 1142, Blus and Connelly 1998, p. 23). Both methamidophos and dimethoate remain registered for use in the United States (Christiansen and Tate in press, p. 21), but we found no further records of sage-grouse mortalities from their use. In 1950, Rangelands treated with toxaphene and chlordane bait in Wyoming to control grasshoppers resulted in game bird mortality of 23.4 percent (Christian and Tate in press, p. 20). Forty-five sage-grouse deaths were recorded, 11 of which were most likely related to the pesticide (Christiansen and Tate in press, p. 20, and references therein). Sage-grouse who succumbed to vehicle collisions and mowing machines in the same area also were likely compromised from pesticide ingestion (Christian and Tate in press, p. 20). Neither of these chemicals has been registered for grasshopper control since the early 1980s (Christiansen and Tate in press, p. 20, and references therein).

Game birds that ingested sub-lethal levels of pesticides have been observed exhibiting abnormal behavior that may lead to a greater risk of predation (Dahlen and Haugen 1954, p. 477; McEwen and Brown 1966, p. 609; Blus *et al*. 1989, p. 1141). McEwen and Brown (1966, p. 689) reported that wild sharp-tailed grouse poisoned by malathion and dieldrin exhibited depression, dullness, slowed reactions, irregular flight, and uncoordinated walking. Although no research has explicitly studied the indirect levels of mortality from sub-lethal doses of pesticides (e.g., predation of impaired birds), it has been assumed to be the reason for mortality among some study birds (McEwen and Brown 1966 p. 609; Blus *et al*. 1989, p. 1142; Connelly and Blus 1991, p. 4). Both Post (1951, p. 383) and Blus *et al*. (1989, p. 1142) located depredated sage-grouse carcasses in areas that had been treated with insecticides. Exposure to these insecticides may have predisposed sage-grouse to predation. Sage-grouse mortalities also were documented in a study where they were exposed to strychnine bait type used to control small mammals (Ward *et al*. 1942 as cited in Schroeder *et al*. 1999, p. 16).

Cropland spraying may affect populations that are not adjacent to agricultural areas, given the distances traveled by females with broods from nesting areas to late brood-rearing areas (Knick *et al*. in press, p. 17). The actual footprint of this effect cannot be estimated, because the distances traveled to get to irrigated and sprayed fields is unknown (Knick *et al*. in press, p. 17). Similarly, actual mortalities from pesticides may be underestimated if sage-grouse disperse from agricultural areas after exposure.

Much of the research related to pesticides that had either lethal or sub-lethal effects on greater sage-grouse was conducted on pesticides that have been banned or have their use further restricted for more than 20 years due to their toxic effects on the environment (e.g., dieldrin). We currently do not have any information to show that the banned pesticides are presently having negative impacts to sage-grouse populations through either illegal use or residues in the environment. For example, sage-grouse mortalities were documented in a study where they were exposed to strychnine bait used to control small mammals (Ward *et al*. 1942 as cited in Schroeder *et al*. 1999, p. 16). According to the U.S. Environmental Protection Agency (EPA), above-ground uses of strychnine were prohibited in 1988 and those uses remain temporarily cancelled today. We do not know when, or if, above ground uses will be permitted to resume. Currently strychnine is registered for use only below-ground as a bait application to control pocket gophers (*Thomomys* sp.; EPA 1996, p. 4). Therefore, the current legal use of strychnine baits is unlikely to present a significant exposure risk to sage-grouse. No information on illegal use, if it occurs, is available. We have no other information regarding mortalities or sublethal effects of strychnine or other banned pesticides on sage-grouse.

Although a reduction in insect population levels resulting from insecticide application can potentially affect nesting sage-grouse females and chicks (Willis *et al*. 1993, p. 40; Schroeder *et al*. 1999, p. 16), we have no information as to whether insecticides are impacting survivorship or productivity of the greater sage-grouse. Eng (1952, pp. 332,334) noted that after a pesticide was sprayed to reduce grasshoppers, songbird and corvid nestling deaths ranged from 50 to 100 percent depending on the chemical used, and stated it appeared that nestling development was adversely affected due to the reduction in grasshoppers. Potts (1986 as cited in Connelly and Blus 1991, p. 93) determined that reduced food supply resulting from the use of pesticides ultimately resulted in high starvation rates of partridge chicks (*Perdix perdix*). In a similar study on partridges, Rands (1985, pp. 51-53) found that pesticide application adversely affected brood size and chick survival by reducing chick food supplies.

Three approved insecticides, carbaryl, diflubenzuron, and malathion, are currently available for application across the extant range of sage-grouse as part of implementation of the Rangeland Grasshopper and Mormon Cricket Suppression Control Program, under the direction of the Animal and Plant Health Inspection Service (APHIS) (APHIS 2004, entire). Carbaryl is applied as bait, while diflubenzuron and malathion are sprayed. APHIS requires that application rates be in compliance with EPA regulations, and APHIS has general guidelines for buffer zones around sensitive species habitats. These pesticides are only applied for grasshopper and Mormon cricket (*Anabrus simplex)* control when requested by private landowners (APHIS 2004). Due to delays in developing nationwide protocols for application procedures, APHIS did not perform any grasshopper or Mormon cricket suppression activities in 2006,

2007, or 2008 (Gentle 2008, pers. comm.). However, due to an anticipated peak year of these pests in 2010, plans for suppression are already in progress.

In the Rangeland Grasshopper and Mormon Cricket Suppression Program Final Environmental Impact Statement—2002 (p.10), APHIS concluded that there ''is little likelihood that the insecticide APHIS would use to suppress grasshoppers would be directly or indirectly toxic to sage-grouse. Treatments would typically not reduce the number of grasshoppers below levels that are present in non-outbreak years.'' APHIS (2002, p. 69) stated that although ''malathion is also an organophosphorus insecticide and carbaryl is a carbamate insecticide, malathion and carbaryl are much less toxic to birds'' than other insecticides associated with effects to sage-grouse or other wildlife. The APHIS risk assessment (pp. 122-184) for this EIS determined that the grasshopper treatments would not directly affect sage-grouse. As to potential effects on prey abundance, APHIS noted that during ''grasshopper outbreaks when grasshopper densities can be 60 or more per square meter (Norelius and Lockwood, 1999), grasshopper treatments that have a 90 to 95 percent mortality still leave a density of grasshoppers (3 to 6) that is generally greater than the average density found on rangeland, such as in Wyoming, in a normal year (Schell and Lockwood, 1997).''

Herbicide applications can kill sagebrush and forbs important as food sources for sage-grouse (Carr 1968 as cited in Call and Maser 1985, p. 14). The greatest impact resulting from a reduction of either forbs or insect populations is for nesting females and chicks due to the loss of potential protein sources that are critical for successful egg production and chick nutrition (Johnson and Boyce 1991, p. 90; Schroeder *et al.* 1999, p. 16). A comparison of applied levels of herbicides with toxicity studies of grouse, chickens, and other gamebirds (Carr 1968, as cited in Call and Maser 1985, p. 15) concluded that herbicides applied at recommended rates should not result in sage-grouse poisonings.

In summary, pesticides can result in direct mortality of individuals, and also can reduce the availability of food sources, which in turn could contribute to mortality of sage-grouse. Despite the potential effects of pesticides, we could find no information to indicate that the use of these chemicals, at current levels, negatively affects greater sage-grouse population numbers. Schroeder *et al.*'s (1999, p.16) literature review found that the loss of insects can have significant impacts on nesting females and chicks, but those impacts were not detailed. Many of the pesticides that have been shown to have an effect on sage-grouse have been banned in the United States for more than 20 years. As previously noted, we currently do not have any information to show that the banned pesticides through either illegal use or residues in the environment are presently having negative impacts to sage-grouse populations.

Contaminants

Greater sage-grouse exposure to various types of environmental contaminants may potentially occur as a result of agricultural and rangeland management practices, mining, energy development and pipeline operations, nuclear energy production and research, and transportation of materials along highways and railroads.

A single greater sage-grouse was found covered with oil and dead in a wastewater pit associated with an oil field development in 2006; the site was in violation of legal requirements for screening the pit (Domenici 2008, pers. comm.). To the extent that this source of mortality occurs, it would be most likely in MZ I and II, as those zones are where most of the oil and gas development occurs in relation to occupied sage-grouse habitat. The extent to which such mortality to greater sage-grouse is occurring is extremely difficult to quantify due to difficulties in retrieving and identifying oiled birds and lack of monitoring. We expect that the number of sage-grouse occurring in the immediate vicinity of such wastewater pits would be small due to the typically intense human activity in these areas, the lack of cover around the pits, and the fact that sage-grouse do not require free water. Most bird mortalities recorded in association with wastewater pits are water-dependent species (e.g., waterfowl), whereas dead ground-dwelling birds (such as the greater sage-grouse) are rarely found at such sites (Domenici 2008, pers. comm.). However, if the wastewater pits are not appropriately screened, sage-grouse may have access to them and could ingest water and/or become oiled while pursing insects. If these birds then return to sagebrush cover and die their carcasses are unlikely to be found as only the pits are surveyed. The effects of areal pollutants resulting from oil and gas development on greater sage-grouse are discussed under the energy development section in Factor A.

Numerous gas and oil pipelines occur within the occupied range of several populations of the species. Exposure to oil or gas from pipeline spills or leaks could cause mortalities or morbidity to greater sage-grouse. Similarly, given the extensive network of highways and railroad lines that occur throughout the range of the greater sage-grouse, there is some potential for exposure to contaminants resulting from spills or leaks of hazardous materials being conveyed along these transportation corridors. We found no documented occurrences of impacts to greater sage-grouse from such spills, and we do not expect they are a significant source of mortality because these types of spills occur infrequently and involve only a small area that might be within the occupied range of the species.

Exposure of sage-grouse to radionuclides (radioactive atoms) has been documented at the DOE's Idaho National Engineering Laboratory in eastern Idaho. Although radionuclides were present in greater sage-grouse at this site, there were no apparent harmful effects to the population (Connelly and Markham 1983, pp. 175-176). There is one site in the range formerly occupied by the species (Nuclear Energy Institute 2004), and construction is scheduled to begin on a new nuclear power plant facility in 2009 in Elmore County, Idaho, near Boise (Nuclear Energy Institute 2008) in MZ IV. At this new facility and any other future facilities developed for nuclear power, if all provisions regulating nuclear energy development are followed, it is unlikely that there will be impacts to sage-grouse as a result of radionuclides or any other nuclear products.

Recreational Activities

Boyle and Samson (1985, pp. 110-112) determined that non-consumptive recreational activities can degrade wildlife resources, water, and the land by distributing refuse, disturbing and displacing wildlife, increasing animal mortality, and simplifying plant communities. Sage-grouse response to disturbance may be influenced by the type of activity, recreationist behavior, predictability of activity, frequency and magnitude, activity timing, and activity location (Knight and Cole 1995, p. 71). Examples of recreational activities in sage-grouse habitats include hiking, camping, pets, and off-highway vehicle (OHV) use. We have not located any published literature concerning measured direct effects of recreational activities on greater sage-grouse, but can infer potential impacts from studies on related species and from research on non-recreational activities. Baydack and Hein (1987, p. 537) reported displacement of male sharp-tailed

grouse at leks from human presence, resulting in loss of reproductive opportunity during the disturbance period. Female sharp-tailed grouse were observed at undisturbed leks while absent from disturbed leks during the same time period (Baydack and Hein 1987, p. 537). Disturbance of incubating female sage-grouse could cause displacement from nests, increased predator risk, or loss of nests. However, disruption of sage-grouse during vulnerable periods at leks, or during nesting or early brood rearing could affect reproduction or survival (Baydack and Hein 1987, pp. 537-538).

Sage-grouse avoidance of activities associated with energy field development (e.g., Holloran 2005, pp. 43, 53, 58; Doherty *et al.* 2008, p. 194) suggests these birds are likely disturbed by any persistent human presence. Additionally, Aldridge *et al.* (2008, p. 988) reported that the density of humans in 1950 was the best predictor of extirpation of greater sage-grouse. The authors also determined that sage-grouse have been extirpated in virtually all counties reaching a human population density of 25 people/km^2 (65people/mi^2) by 1950. However, their analyses considered all impacts of human presence and did not separate recreational activities from other associated activities and infrastructure. The presence of pets in proximity to sage-grouse can result in sage-grouse mortality or disturbance, and increases in garbage from human recreationists can attract sage-grouse predators and help maintain their numbers at increased levels (cite). Leu *et al.* (2008, p. 1133) reported that slight increases in human densities in ecosystems with low biological productivity (such as sagebrush) may have a disproportionally negative impact on these ecosystems due to the potentially reduced resiliency to anthropogenic disturbance.

Indirect effects to sage-grouse from recreational activities include impacts to vegetation and soils, and facilitating the spread of invasive species. Payne *et al.* (1983, p. 329) studied off-road vehicle impacts to rangelands in Montana, and found long-term (2 years) reductions in sagebrush shrub canopy cover as the result of repeated trips in the area. Increased sediment production and decreased soil infiltration rates were observed after disturbance by motorcycles and four-wheel drive trucks on two desert soils in southern Nevada (Eckert *et al.* 1979, p. 395), and noise from these activities can cause disturbance (Knick *et al.* in press, p.24).

Recreational use of OHVs is one of the fastest-growing outdoor activities. In the western United States, greater than 27 percent of the human population used OHVs for recreational activities between 1999 and 2004 (Knick *et al.*, *in press*, p. 19). Off-highway vehicle use was a primary factor listed for 13 percent of species either listed under the Act or proposed for listing (Knick *et al.* in press, p. 24). Knick *et al.* (in press, p. 1) reported that widespread motorized access for recreation subsidized predators adapted to humans and facilitated the spread of invasive plants. Any high-frequency human activity along established corridors can affect wildlife through habitat loss and fragmentation (Knick *et al.* in press, p. 25). The effects of OHV use on sagebrush and sage-grouse have not been directly studied (Knick *et al.* in press, p. 25). However, a review of local sage-grouse conservation plans indicated that local working groups considered off-road vehicle use to be a risk factor in many areas.

We are unaware of scientific reports documenting direct mortality of greater sage-grouse through collision with off-road vehicles. Similarly, we did not locate any scientific information documenting instances where snow compaction as a result of snowmobile use precluded greater sage-grouse use, or affected their survival in wintering areas. Off-road vehicle or snowmobile use in winter areas may increase stress on birds and displace sage-grouse to less optimal habitats. However, there is no empirical evidence available documenting these effects on sage-grouse, nor could we find any scientific data supporting the possibility that stress from vehicles during winter is limiting greater sage-grouse populations.

Given the continuing influx of people into the western United States (see discussion under Urbanization, Factor A; Leu and Hanser, in press, p. 4), which is contributed to in part by access to recreational opportunities on public lands, we anticipate effects from recreational activity will continue to increase. The foreseeable future for this effect spans for greater than 100 years, as we do not anticipate the desire for outdoor recreational activities will diminish.

Life History Traits Affecting Population Viability

Sage-grouse have comparatively low reproductive rates and high annual survival (Schroeder *et al.* 1999 pp. 11, 14; Connelly *et al.* 2000a, pp. 969-970), resulting in slower potential or intrinsic population growth rates than is typical of other game birds. Therefore, recovery of populations after a decline may require years. Also, as a consequence of their site fidelity to breeding and brood-rearing habitats (Lyon and Anderson 2003, p. 489), measurable population effects may lag behind negative habitat impacts (Wiens and Rotenberry 1985, p. 666). While these natural history characteristics would not limit sage-grouse populations across large geographic scales under historical conditions of extensive habitat, they may contribute to local population declines when humans alter habitats or mortality rates.

Sage-grouse have one of the most polygamous mating systems observed among birds (Deibert 1995, p. 92). Asymmetrical mate selection (where only a few of the available members of one sex are selected as mates) should result in reduced effective population sizes (Deibert 1995, p. 92), meaning the actual amount of genetic material contributed to the next generation is smaller than predicted by the number of individuals present in the population. With only 10 to 15 percent of sage-grouse males breeding each year (Aldridge and Brigham 2003, p. 30), the genetic diversity of sage-grouse would be predicted to be low. However, in a recent survey of 16 greater sage-grouse populations, only the Columbia Basin population in Washington showed low genetic diversity, likely as a result of long-term population declines, habitat fragmentation, and population isolation (Benedict *et al.* 2003, p. 308; Oyler-McCance *et al.* 2005, p. 1307). The level of genetic diversity in the remaining range of sage-grouse has generated a great deal of interest in the field of behavioral ecology, specifically sexual selection (Boyce 1990, p. 263; Deibert 1995, p. 92-93). There is some evidence of off-lek copulations by subordinate males, as well as multiple paternity within one clutch (Connelly *et al.* 2004, p. 8-2; Bush 2009, p. 108). Dispersal also may contribute to genetic diversity, but little is known about dispersal in sage-grouse (Connelly *et al.* 2004, p. 3-5). However, the lek breeding system suggests that population sizes in sage-grouse must be greater than in non-lekking bird species to maintain long-term genetic diversity.

Aldridge and Brigham (2003, p. 30) estimated that up to 5,000 individual sage-grouse may be necessary to maintain an effective population size of 500 birds. Their estimate was based on individual male breeding success, variation in reproductive success of males that do breed, and the death rate of juvenile birds. We were unable to find any other published estimates of minimal population sizes necessary to maintain genetic diversity and long-term population sustainability in sage-

grouse. However, the minimum viable population size necessary to sustain the evolutionary potential of a species (retention of sufficient genetic material to avoid the effect of inbreeding depression or deleterious mutations) has been estimated as high as an adult population of 5,000 individuals (Traill *et al.* 2010, p. 32). Many sage-grouse populations have already been estimated at well below that value (see Garton *et al.* in press and discussions under Factor A), suggesting their evolutionary potential (ability to persist long-term) has already been compromised if that value is correct.

Drought

Drought is a common occurrence throughout the range of the greater sage-grouse (Braun 1998, p. 148) and is considered a universal ecological driver across the Great Plains (Knopf 1996, p.147). Infrequent, severe drought may cause local extinctions of annual forbs and grasses that have invaded stands of perennial species, and recolonization of these areas by native species may be slow (Tilman and El Haddi 1992, p. 263). Drought reduces vegetation cover (Milton *et al.* 1994, p. 75; Connelly *et al.* 2004, p. 7-18), potentially resulting in increased soil erosion and subsequent reduced soil depths, decreased water infiltration, and reduced water storage capacity. Drought also can exacerbate other natural events such as defoliation of sagebrush by insects. For example, approximately 2,544 km^2 (982 mi^2) of sagebrush shrublands died in Utah in 2003 as a result of drought and infestations with the *Aroga* (webworm) moth (Connelly *et al.* 2004, p. 5-11). Sage-grouse are affected by drought through the loss of vegetative habitat components, reduced insect production (Connelly and Braun 1997, p. 9), and potentially exacerbation of WNv infections as described in Factor C above. These habitat component losses can result in declining sage-grouse populations due to increased nest predation and early brood mortality associated with decreased nest cover and food availability (Braun 1998, p. 149; Moynahan 2007, p. 1781).

Sage-grouse populations declined during the 1930s period of drought (Patterson 1952, p. 68; Braun 1998, p. 148). Drought conditions in the late 1980s and early 1990s also coincided with a period when sage-grouse populations were at historically low levels (Connelly and Braun 1997, p. 8). From 1985 through 1995, the entire range of sage-grouse experienced severe drought (as defined by the Palmer Drought Severity Index) with the exceptions of north-central Colorado (MZ II) and southern Nevada (MZ III). During this time period drought was particularly prevalent in southwestern Wyoming, Idaho, central Washington and Oregon, and northwest Nevada (University of Nebraska 2008). Abnormally dry to severe drought conditions still persist in Nevada and western Utah (MZ III and IV), Idaho (MZ IV), northern California and central Oregon (MZ V), and southwest Wyoming (MZ II) (University of Nebraska 2008).

Aldridge *et al.* (2008, p. 992) found that the number of severe droughts from 1950 to 2003 had a weak negative effect on patterns of sage-grouse persistence. However, they cautioned that drought may have a greater influence on future sage-grouse populations as temperatures rise over the next 50 years, and synergistic effects of other threats affect habitat quality (Aldridge *et al.* 2008, p. 992). Populations on the periphery of the range may suffer extirpation during a severe and prolonged drought (Wisdom *et al.* in press, p. 22).

In summary, drought has been a consistent and natural part of the sagebrush-steppe ecosystem and there is no information to suggest that drought was a cause of persistent population declines of greater sage-grouse under historic conditions. However, drought impacts on the greater sage-grouse may be exacerbated when combined with other habitat impacts that reduce cover and food (Braun 1998, p. 148).

Summary of Factor E

Numerous factors have caused sage-grouse mortality, and probably morbidity, such as pesticides, contaminants, as well as factors that contribute to direct and indirect disturbance to sage-grouse and sagebrush, such as recreational activities. Drought has been correlated with population declines in sage-grouse, but is only a limiting factor where habitats have been compromised. Although we anticipate use of pesticides, recreational activities, and fluctuating drought conditions to continue indefinitely, we did not find any evidence that these factors, either separately, or in combination are resulting in local or range-wide declines of greater sage-grouse. New information regarding minimum population sizes necessary to maintain the evolutionary potential of a species suggests that sage-grouse in some areas throughout their range may already be at population levels below that threshold. This is a result of habitat loss and modification (discussed under Factor A).

We have evaluated the best available scientific information on other natural or manmade factors affecting the species' continued existence and determined that this factor does not singularly pose a significant threat to the species now or in the foreseeable future.

Findings

Finding on Petitions to List the Greater Sage-Grouse Across Its Entire Range

As required by the Act, we have carefully examined the best scientific and commercial information available in relation to the five factors used to assess whether the greater sage-grouse is threatened or endangered throughout all or a significant portion of its range. We reviewed the petitions, information available in our files, other available published and unpublished information, and other information provided to us after our notice initiating a status review of the greater sage-grouse was published. We also consulted with recognized greater sage-grouse and sagebrush experts and other Federal and State agencies.

In our analysis of Factor A, we identified and evaluated the present or threatened destruction, modification, or curtailment of the habitat or range of the greater sage-grouse from various causes, including: habitat conversion for agriculture; urbanization; infrastructure (e.g., roads, powerlines, fences) in sagebrush habitats; fire; invasive plants; pinyon-juniper woodland encroachment; grazing; energy development; and climate change. All of these, individually and in combination, are contributing to the destruction, modification, or curtailment of the greater sage-grouse's habitat or range. Almost half of the sagebrush habitat estimated to have been present historically has been destroyed. The impact has been greatly compounded by the fragmented nature of this habitat loss, as fragmentation results in functional habitat loss for greater sage-grouse even when otherwise suitable habitat is still present. Although sagebrush habitats are increasingly being destroyed, modified, and fragmented for multiple reasons, the impact is especially great in relation to fire and invasive plants (and the interaction between them) in more westerly parts of the range, and energy development and related infrastructure in more easterly areas. In addition, direct loss of habitat and fragmentation is occurring due to agriculture, urbanization, and infrastructure such as roads and powerlines built in support of several activities. Some of these habitat losses due to these activities occurred many years ago, but they continue to

have an impact due to the resulting fragmentation. Renewed interest in agricultural activities in areas previously defined as unsuitable for these activities, due to economic and technological incentives are likely to increase habitat loss and fragmentation from agricultural conversion. Encroachment of pinyon and juniper woodland into sagebrush is increasing and likely to continue in several areas, altering the structure and composition of habitat to the point that is it is greatly diminished or of no value to sage-grouse. While effects of livestock grazing must be assessed locally, the continued removal of sagebrush to increase forage directly fragments habitat, and indirectly provides for fragmentation through fencing and opportunities for invasive plant incursion. Habitat loss and fragmentation also is very likely to increase as a result of increased temperatures and changes in precipitation regimes associated with the effects of climate change; also, the impacts of fire and invasive plants likely already are, and will continue to be, exacerbated by the effects of climate change.

Sagebrush restoration techniques are limited and generally ineffective. Further, restoring full habitat function may not be possible in some areas because alteration of vegetation, nutrient cycles, topsoil, and cryptobiotic crusts have exceeded the point beyond which recovery to pre-disturbance conditions or conditions suitable to populations of greater sage-grouse, is possible.

The impacts to habitat are not uniform across the range; some areas have experienced less habitat loss than others, and some areas are at relatively lower risk than others for future habitat destruction or modification. Nevertheless, the destruction and modification of habitat has been substantial in many areas across the range of the species, it is ongoing, and it will continue or even increase in the future. Many current populations of greater sage-grouse already are relatively small and connectivity of habitat and populations has been severely diminished across much of the range; and further isolation is likely for several populations. Even the Wyoming Basin and the Great Basin area where Oregon, Nevada, and Idaho intersect, which are the two stronghold areas with relatively large amounts of contiguous sagebrush and sizeable populations of sage-grouse, are experiencing habitat destruction and modification (e.g. as a result of oil and gas development and other energy development in the Wyoming Basin) and this will continue in the future. Several recent studies have demonstrated that sagebrush area is one of the best landscape predictors of greater sage-grouse persistence. Continued habitat destruction and modification, compounded by fragmentation and diminished connectivity, will result in reduced abundance and further isolation of many populations over time, increasing their vulnerability to extinction. Overall, this increases the risk to the entire species across its range.

Therefore, based on our review of the best scientific and commercial information available, we find that the present or threatened destruction, modification, or curtailment of the habitat or range of the greater sage-grouse is a significant threat to the species now and in the foreseeable future.

During our review of the best scientific and commercial information available, we found no evidence of risks from overutilization for commercial, recreational, scientific, or education affecting the species as a whole. Although the allowable harvest of sage-grouse through hunting was very high in past years, substantial reductions in harvest began during the 1990s and have continued to drop, and since approximately 2000 total mortality due to hunting has been lower than in the last 50 years. The present level of hunting mortality shows no sign of being a significant threat to the species. However, in light of present and threatened habitat loss (Factor A) and other considerations (e.g. West Nile virus outbreaks in local populations), States and tribes will need to continue to carefully manage hunting mortality, including adjusting seasons and harvest levels, and imposing emergency closures if needed. Therefore, we conclude that the greater sage-grouse is not threatened by overutilization for commercial, recreational, scientific, or educational purposes now or in the foreseeable future.

We found that while greater sage-grouse are subject to various diseases, the only disease of concern is West Nile virus. Outbreaks of WNv have resulted in disease-related mortality is local areas. Because greater sage-grouse have little or no resistance to this disease, the likelihood of mortality of affected individuals is extremely high. Currently the annual patchy distribution of the disease is resulting in minimal impacts except at local scales. We are concerned by the proliferation of water sources associated with various human activities, particularly water sources developed in association with coal bed methane and other types of energy development, as they provide potential breeding habitat for mosquitoes that can transmit WNv. We expect the prevalence of this disease is likely to increase across much of the species' range, but understand the long-term response of different populations is expected to vary markedly. Further, a complex set of conditions that support the WNv cycle must coincide for an outbreak to occur, and consequently although we expect further outbreaks will occur and may be more widespread, they likely will still be patchy and sporadic. We found that while greater sage-grouse are prey for numerous species, and that nest predation by ravens and other human-subsidized predators may be increasing and of potential concern in areas of human development, no information indicates that predation is having or is expected to have an overall adverse effect on the species. Therefore, at this time, we find that neither disease nor predation is a sufficiently significant threat to the greater sage-grouse now or in the foreseeable future that it requires listing under the Act as threatened or endangered based on this factor.

Our review of the adequacy of existing regulatory mechanisms included mechanisms in both Canada (less than 2 percent of the species' range) and the United States. Greater sage-grouse are federally protected in Canada as an endangered species under that country's Species at Risk Act. The species also is listed as endangered by the provinces of Alberta and Saskatchewan, and neither province allows harvest. In Alberta, individual birds are protected, but their habitat is not. The Saskatchewan Wildlife Act restricts development within 500 m (1,640 ft) of leks and prohibits construction within 1,000 m (3,281 ft) of leks from March 15 – May 15, but numerous studies have shown these buffers are inadequate to protect sage-grouse, particularly in nesting areas.

We found very few mechanisms in place at the level of local governments that provide, either directly or indirectly, protections to the greater sage-grouse or its habitat. The species receives some protection under laws of each of the States currently occupied by greater sage-grouse, including hunting regulations and various other direct and indirect mechanisms. However, in most states these provide little or no protection to greater sage-grouse habitat. Colorado recently implemented State regulations regarding oil and gas development, but they apply only to new developments and prescribe a process rather than specific measures

that we can evaluate or rely on to provide protection related to the covered actions. In Wyoming, a Governor's Executive Order (E. O. 2008-2) outlines a strategic framework of core habitat areas that may provide the adequate scale of conservation needed over time to ensure the long-term conservation of greater sage-grouse in the state, but currently only the provisions for Wyoming State lands show promise as regulatory mechanisms, affecting only a small portion of the species' range in Wyoming.

The majority of greater sage-grouse habitat is on Federal land, particularly areas administered by the Bureau of Land Management, and to a lesser extent the U.S. Forest Service. We found a diverse network of laws and regulations that relate directly or indirectly to protections for the greater sage-grouse and its habitat on Federal lands, including BLM and FS lands. However, the extent to which the BLM and FS have adopted and adequately implemented appropriate measures to conserve the greater sage-grouse and its habitat varies widely across the range of the species. Regulatory mechanisms addressing the ongoing threats related to habitat destruction and modification, particularly as related to fire, invasive plants, and energy development, are not adequate. There are no known existing regulatory mechanisms currently in place at the local, State, national, or international level that effectively address climate-induced threats to greater sage-grouse habitat. In summary, based on our review of the best scientific information available, we conclude that the inadequacy of existing regulatory mechanisms is a significant threat to the greater sage-grouse now and in the foreseeable future.

We assessed the potential risks from other natural or manmade factors including pesticides, contaminants, recreational activities, life history traits, and drought. We did not find any evidence these factors, either separately or in combination, pose a risk to the species. Therefore, we find that other natural and manmade factors affecting the continued existence of the species do not threaten the greater sage-grouse now or in the foreseeable future.

The greater sage-grouse occurs across 11 western States and 2 Canadian provinces and is a sagebrush obligate. Although greater sage-grouse have a wide distribution, their numbers have been declining since consistent data collection techniques have been implemented. Recent local moderations in the decline of populations indicate a period of relative population stability, particularly since the mid-1990s. This trend information was one key basis for our decision in 2005 that listing the greater sage-grouse was not warranted. The population trends appear to have continued to be relatively stable. However, our understanding of the status of the species and the threats affecting it has changed substantially since our decision in 2005. In particular, numerous scientific papers and reports with new and highly relevant information have become available, particularly during the past year.

Although the declining population trends have moderated over the past several years, low population sizes and relative lack of any sign of recovery across numerous populations is troubling. Previously, fluctuations in sage-grouse populations were apparent over time (based on lek counts as an index). However, these have all but ceased for several years, suggesting some populations may be at a point where they are unable and unlikely to increase due to habitat limitations, perhaps in combination with other factors. Also, we are aware of the likelihood of a lag effect in some areas, because population trend and abundance estimates are not based on information about reproductive success and population recruitment, but instead are based on the number of adult males observed during lek counts. Because of the relative longevity of adult sage-grouse, the lek counts of males could continue to suggest relative stability even when a population is actually declining.

Overall, the range of the species is now characterized by numerous relatively small populations existing in a patchy mosaic of increasingly fragmented habitat, with diminished connectivity. Many areas lack sufficient unfragmented sagebrush habitats on a scale, and with the necessary ecological attributes (e.g., connectivity and landscape context), needed to address risks to population persistence and support robust populations. Relatively small and isolated populations are more vulnerable to further reduction over time, including increased risk of extinction due to stochastic events. Two strongholds of relatively contiguous sagebrush habitat (southwestern Wyoming and northern Nevada, southern Idaho, southeastern Oregon and northwestern Utah) with large populations which are considered strongholds for the species are also being impacted by direct habitat loss and fragmentation that will continue for the foreseeable future.

We have reviewed and taken into account efforts being made to protect the species, as required by the Act. Although some local conservation efforts have been implemented and are effective in small areas, they are neither individually nor collectively at a scale that is sufficient to ameliorate threats to the species or populations. Many other conservation efforts are being planned but there is substantial uncertainty as to whether, where, and when they will be implemented, and whether they will be effective.

We have carefully assessed the best scientific and commercial information available regarding the present and future threats to the greater sage-grouse. We have reviewed the petition, information available in our files, and other published and unpublished information, and consulted with recognized greater sage-grouse and sagebrush experts. We have reviewed and taken into account efforts being made to protect the species. On the basis of the best scientific and commercial information available, we find that listing the greater sage-grouse is warranted across its range. However, listing the species is precluded by higher priority listing actions at this time, as discussed in the **Preclusion and Expeditious Progress** section below.

We have reviewed the available information to determine if the existing and foreseeable threats render the species at risk of extinction now such that issuing an emergency regulation temporarily listing the species as per section 4(b)(7) of the Act is warranted. We have determined that issuing an emergency regulation temporarily listing the greater sage-grouse is not warranted at this time (see discussion of listing priority, below). However, if at any time we determine that issuing an emergency regulation temporarily listing the species is warranted, we will initiate this action at that time.

Finding on the Petition to List the Western Subspecies of the Greater Sage-Grouse

As described in the Taxonomy section, above, we have reviewed the best scientific information available on the geographic distribution, morphology, behavior, and genetics of sage-grouse in relation to putative eastern and western subspecies of sage-grouse, as formally recognized by the AOU in 1957 (AOU 1957, p. 139). The AOU has not published a revised list of subspecies of birds since 1957, and has acknowledged that some of the subspecies probably cannot be validated by rigorous modern techniques (AOU 1998, p. xii). The Service previously made a finding that the eastern subspecies is not a valid taxon and thus

is not a listable entity (69 FR 933, January 7, 2004,), and the Court dismissed a legal challenge to that finding (see Previous Federal Action, above). Thus the 12–month petition finding we are making here is limited to the petition to list the western subspecies.

To summarize the information presented in the Taxonomy section (above), our status review shows the following with regard to the putative western subspecies: (1) there is insufficient information to demonstrate that the petitioned western sage-grouse can be geographically differentiated from other greater sage-grouse throughout the range of the taxon; (2) there is insufficient information to demonstrate that morphological or behavioral aspects of the petitioned western subspecies are unique or provide any strong evidence to support taxonomic recognition of the subspecies; and (3) genetic evidence does not support recognition of the western sage-grouse as a subspecies. To be eligible for listing under the Act, an entity must fall within the Act's definition of a species, ''*** any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature'' (Act, section 3(16)). Based on our review of the best scientific information available, we conclude that the western subspecies is not a valid taxon, and consequently is not a listable entity under the Act. Therefore, we find that listing the western subspecies is not warranted.

We note that greater sage-grouse covered by the petition to list the putative western subspecies (except for those in the Bi-State area, which are covered by a separate finding, below) are encompassed by our finding that listing the greater sage-grouse rangewide is warranted but precluded (see above). Further, greater sage-grouse within the Columbia Basin of Washington were designated as warranted, but precluded for listing as a DPS of the western subspecies in 2001 (65 FR 51578, May 7, 2001). However, with our finding that the western subspecies is not a listable entity, we acknowledge that we must reevaluate the status of the Columbia Basin population as it relates to the greater sage-grouse; we will conduct this analysis as our priorities allow.

Finding on the Petitions to List the Bi-State Area (Mono Basin) Population

As described above we received two petitions to list the Bi-State (Mono Basin) area populations of greater sage-grouse as a Distinct Population Segment. Please see the section titled ''Previous federal actions'' for a detailed history and description of these petitions. In order to make a finding on these petitions, we must first determine whether the greater sage-grouse in the Bi-State area constitute a DPS, and if so, we must conduct the relevant analysis of the five factors that are the basis for making a listing determination.

Distinct Vertebrate Population Segment (DPS) Analysis

Under section 4(a)(1) of the Act, we must determine whether any species is an endangered species or a threatened species because of any of the five threat factors identified in the Act. Section 3(16) of the Act defines ''species'' to include ''any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature'' (16 U.S.C. 1532 (16)). To interpret and implement the distinct population segment portion of the definition of a species under the Act and Congressional guidance, the Service and the National Marine Fisheries Service (now the National Oceanic and Atmospheric Administration–Fisheries) published, on February 7, 1996, an interagency Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Act (61 FR 4722) (DPS Policy). The DPS Policy allows for more refined application of the Act that better reflects the conservation needs of the taxon being considered and avoids the inclusion of entities that may not warrant protection under the Act.

Under our DPS Policy, we consider three elements in a decision regarding the status of a possible DPS as endangered or threatened under the Act. We apply them similarly for additions to the List of Endangered and Threatened Wildlife, reclassification, and removal from the List. They are: (1) Discreteness of the population segment in relation to the remainder of the taxon; (2) the significance of the population segment to the taxon to which it belongs; and (3) the population segment's conservation status in relation to the Act's standards for listing (whether the population segment is, when treated as if it were a species, endangered or threatened). Discreteness is evaluated based on specific criteria provided in the DPS Policy. If a population segment is considered discrete under the DPS Policy we must then consider whether the discrete segment is ''significant'' to the taxon to which it belongs. If we determine that a population segment is discrete and significant, we then evaluate it for endangered or threatened status based on the Act's standards. The DPS evaluation in this finding concerns the Bi-State (Mono Basin) area greater sage-grouse that we were petitioned to list as threatened or endangered, as stated above.

Discreteness Analysis

Under our DPS Policy, a population segment of a vertebrate species may be considered discrete if it satisfies either one of the following conditions: (1) It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors (quantitative measures of genetic or morphological discontinuity may provide evidence of this separation); or

(2) it is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act.

Markedly Separated From Other Populations of the Taxon

Bi-State area greater sage-grouse are genetically unique compared with other populations of greater sage-grouse. Investigations using both mitochondrial DNA sequence data and data from nuclear microsatellites have demonstrated that Bi-State area greater sage-grouse contain a large number of unique haplotypes not found elsewhere within the range of the greater sage-grouse (Benedict *et al.* 2003, p. 306; Oyler–McCance *et al.* 2005, p. 1300). The genetic diversity present in the Bi-State population was comparable to other populations suggesting that the differences were not due to a genetic bottleneck or founder event (Oyler–McCance and Quinn *in press*, p. 18). These genetic studies provide evidence that the present genetic uniqueness exhibited by Bi-State area greater sage-grouse developed over thousands and perhaps tens of thousands of years (Benedict *et al.* 2003, p. 308; Oyler–McCance *et al.* 2005, p. 1307), which predates Euro-American settlement.

The Service's DPS Policy states that quantitative measures of genetic or morphological discontinuity may be used as evidence of the marked separation of a population from other populations of the same taxon. In the Bi-State area, the present genetic uniqueness is most likely a manifestation of prehistoric physical isolation. Based on the reported timeline (thousands to tens of thousands of years) (Benedict *et al.* 2003, p. 308), isolation of this population may have

begun during the Wisconsin Stage of the Pleistocene Epoch (from approximately 25,000 to 9,000 years before present (ybp)), when Ancient Lake Lahontan covered much of western Nevada. After the lake receded (approximately 9,000 ybp), barriers to genetic mixing remained. Physical barriers in the form of inhospitable habitats (Sierra-Nevada Mountains, salt desert scrub, Mojave Desert) in most directions maintained this isolation. With the establishment of Virginia City, Nevada (1859), any available corridor that connected the Bi-State area to the remainder of the greater sage-grouse range was removed.

Currently, no greater sage-grouse occur in the Virginia Range, having been extirpated several decades ago. The population in closest proximity to the Bi-State area occurs in the Pah Rah Range to the northeast of Reno, Nevada, and approximately 50 km (31 mi) to the north of the Bi-State area. The Pah Rah Range occurs immediately to the north of the Virginia Range and south of the Virginia Mountains. It is currently unknown if the small remnant population occurring in the Pah Rah Range aligns more closely with the Bi-State birds or the remainder of the greater sage-grouse. The range delineation occurs south of the Virginia Mountains in one of three locations: (1) the small population occurring in the Pah Rah Range, (2) the extirpated population historically occurring in the Virginia Range, or (3) the Pine Nut Mountains. Limited studies of behavioral differences between the Bi-State population and other populations have not demonstrated any gross differences that suggest behavioral barriers (Taylor and Young 2006, p. 39).

Conclusion for Discreteness

We conclude the Bi-State population of greater sage-grouse is markedly separate from other populations of the greater sage-grouse based on genetic data from mitochondrial DNA sequencing and from nuclear microsatellites. The Bi-State area greater sage-grouse contain a large number of unique haplotypes not found elsewhere within the range of the species. The present genetic uniqueness exhibited by Bi-State area greater sage-grouse occurred over thousands and perhaps tens of thousands of years (Benedict *et al.* 2003, p. 308; Oyler-McCance *et al.* 2005, p. 1307) and continues through today due to physical isolation from the remainder of the range. These genetic data are the principal basis for our conclusion that the Bi-State area greater sage-grouse are markedly separated from other populations of greater sage-grouse and therefore are discrete under the Service's DPS Policy.

Significance Analysis

The DPS Policy states that if a population segment is considered discrete under one or both of the discreteness criteria, its biological and ecological significance will then be considered in light of Congressional guidance that the authority to list DPSs be used ''sparingly'' while encouraging the conservation of genetic diversity. In carrying out this examination, the Service considers available scientific evidence of the DPS's importance to the taxon to which it belongs. As specified in the DPS Policy, this consideration of the significance may include, but is not limited to, the following: (1) persistence of the discrete population segment in an ecological setting unusual or unique to the taxon; (2) evidence that its loss would result in a significant gap in the range of the taxon; (3) evidence that it is the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historical range; or (4) evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics. The DPS Policy further states that because precise circumstances are likely to vary considerably from case to case, it is not possible to describe prospectively all the classes of information that might bear on the biological and ecological importance of a discrete population segment.

(1) Persistence of the discrete population segment in an ecological setting unusual or unique to the taxon. The Bi-State area greater sage-grouse population occurs in the Mono province (Rowland *et al.* 2003, p. 63). This ecological province is part of the Great Basin, and on a gross scale the ecological provinces that comprise this area are characterized by basin and range topography. Basin and range topography covers a large portion of the western United States and northern Mexico. It is typified by a series of north–south-oriented mountain ranges running parallel to each other, with arid valleys between the mountains. Most of Nevada and eastern California comprise basin and range topography with only slight variations in floristic patterns. Hence, we do not consider Bi-State area greater sage-grouse to occur in an ecological setting that is unique for the taxon.

(2) Evidence that its loss would result in a significant gap in the range of the taxon. The estimated total extant range of greater sage-grouse is 668,412 km^2 (258,075 mi^2) (Schroeder *et al.* 2004, p. 363) compared to approximately 18,310 km^2 (7,069 mi^2) for the Bi-State area sage-grouse (Bi-State Plan 2004). Bi-State area sage-grouse therefore occupy about 3 percent of the total extant range of greater sage-grouse. Loss of this population would not create a gap in the remainder of the species range because the Bi-State population does not provide for connectivity for other portions of the range. Therefore, we conclude that loss of this population would not represent a significant gap in the range of the species.

(3) Evidence that it is the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historical range. Bi-State area greater sage-grouse are not the only surviving occurrence of the taxon and represent a small proportion of the total extant range of the species.

(4) Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics. Genetic analyses show the Bi-State area sage-grouse have a large number of unique haplotypes not found elsewhere in the range of the species (Benedict *et al.* 2003, p. 306; Oyler-McCance *et al.* 2005, p. 1300). Benedict *et al.* (2003, p. 309) indicated that the preservation of genetic diversity represented by this unique allelic composition is of particular importance for conservation.

On the basis of the discussion presented above, we conclude the Bi-State greater sage-grouse population meets the significance criterion of our DPS Policy.

Conclusion of Distinct Population Segment Review

Based on the best scientific and commercial data available, as described above, we find that under our DPS Policy, the Bi-State greater sage-grouse population is discrete and significant to the overall species. Because the Bi-State greater sage-grouse population is both discrete and significant, we find that it is a distinct population segment under our DPS Policy. We refer to this population segment as the Bi-State DPS of the greater sage-grouse.

Conservation Status

Pursuant to the Act, as stated above, we announced our determination that the petitions to list the Bi-State area population of greater sage-grouse contained substantial information that the action may be warranted. Having found the Bi-State population qualifies as a DPS, we now must consider, based on the best available scientific and

commercial data whether the DPS warrants listing. We have evaluated the conservation status of the Bi-State DPS of the greater sage-grouse in order to make that determination. Our analysis follows below.

Life History Characteristics

Please see this section of the greater sage-grouse 12–month petition finding (GSG finding) above for life history information.

Habitat Description and Characteristics

Please see this section of the GSG finding, above, for information on sage-grouse habitat.

Distribution

The Bi-State DPS of the greater sage-grouse historically occurred throughout most of Mono, eastern Alpine, and northern Inyo Counties, California (Hall *et al.* 2008, p. 97), and portions of Carson City, Douglas, Esmeralda, Lyon, and Mineral Counties, Nevada (Gullion and Christensen 1957, pp. 131–132; Espinosa 2006a, pers. comm.). Although the current range of the population in California was presumed reduced from the historical range (Leach and Hensley, 1954, p. 386; Hall 1995, p. 54; Schroeder *et al.* 2004, pp. 368–369), the extent of loss is not well understood and there may, in fact, have been no net loss (Hall *et al.* 2008, p. 96) in the California portion of the Bi-State area. Gullion and Christensen (1957, pp. 131–132) reported that greater sage-grouse occurred in Esmeralda, Mineral, Lyon, and Douglas Counties. However, parts of Carson City County were likely part of the original range of the species in Nevada and it is possible that greater sage-grouse still persist there (Espinosa 2006a, pers. comm.). The extent of the range loss in the Nevada portion of the Bi-State area not been estimated (Stiver 2002, pers. comm.).

In 2001, the State of Nevada sponsored development of the *Nevada Sage-Grouse Conservation Strategy* (Sage-Grouse Conservation Planning Team 2001). This Strategy established Population Management Units (PMUs) for Nevada and California as management tools for defining and monitoring greater sage-grouse distribution (Sage-Grouse Conservation Planning Team 2001, p. 31). The PMU boundaries are based on aggregations of leks, greater sage-grouse seasonal habitats, and greater sage-grouse telemetry data (Sage-Grouse Conservation Planning Team 2001, p. 31). The PMUs that comprise the Bi-State planning area are Pine Nut, Desert Creek–Fales, Mount Grant, Bodie, South Mono, and White Mountains (Figure 4).

[INSERT FIGURE 4]

Currently in the Bi-State area, sage-grouse leks occur in all of the delineated PMUs, with the greatest concentration of leks occurring in the Bodie and South Mono PMUs. Historically there were as many as 122 lek locations in the Bi-State area, although not all were active in any given year. This number is likely inflated due to observer and mapping error. The Nevada Department of Wildlife (NDOW) reports a total of 89 known leks in the Bi-State area (NDOW 2008, p. 7; NDOW 2009, unpublished data). Of these, approximately 39 are considered active and approximately 30 appear to be core leks or occupied annually.

- In the Pine Nut PMU, there are 10 known leks, 4 of which are considered active. Only 1 or 2 appear to be core leks (occupied annually) with the remainder considered satellite leks (active during years of high bird abundance).
- In the Desert Creek–Fales PMU, there are 19 known leks on the Nevada portion consisting of 8 active leks and probably 4 core leks. In California, on the Fales portion of this PMU, there are 6 known leks consisting of 2 or 3 core leks and 3 satellite leks.
- In the Mount Grant PMU, there are 12 known leks with 8 active leks. Of the active leks, 2 to 4 appear to be annually attended. Survey data are limited, and it is not known how many leks are active on an annual basis versus in years of high bird abundance.
- In the Bodie PMU, 29 leks have been mapped. Approximately 7 to 8 appear to be core leks, 6 to 12 appear to be satellite locations, and the remainder are not well defined (i.e., satellites or changes in lek focal activity, poorly mapped, one-time observations).
- In the South Mono PMU there are 9 leks in the Long Valley area near Mammoth Lakes, most of which are annually active. Additionally, 1 lek occurs in the Parker Meadows area south of Lee Vining, and 2 leks occurred along Highway 120 at the base of Granite Mountain and in Adobe Valley but these 2 leks may be extirpated.
- In the White Mountains PMU 2 leks appear active in California in the vicinity of the Mono and Inyo County line, and the NDOW reports 5 active leks in Esmeralda County.

Due to long-term and extensive survey efforts, it is unlikely that new leks will be found in the Nevada or California portions of the Pine Nut and Desert Creek–Fales PMUs or the Bodie and South Mono PMUs in California (Espinosa 2006b, pers. comm.; Gardner 2006, pers. comm.). It is possible that unknown leks exist in the Mount Grant PMU and the Nevada and California portions of the White Mountains PMU, as these PMUs are less accessible resulting in reduced survey effort (Espinosa 2006b, pers. comm.; Gardner 2006, pers. comm.).

Based on landownership, 46 percent of leks in the Bi-State area occur on Bureau of Land Management (BLM) lands, 25 percent occur on U.S. Forest Service (USFS) lands, 17 percent occur on private land, 7 percent occur on Los Angeles Department of Water and Power (LADWP) lands, 4 percent occur on Department of Defense (DOD) lands, and 1 percent occur on State of California lands (Espinosa 2006c, pers. comm.; Taylor 2006, pers. comm.). Of the 30-35 core leks in the Bi-State area, only 3 are known to occur on private lands.

Population Trend and Abundance

In 2004, WAFWA conducted a partial population trend analysis for the Bi-State area (Connelly *et al.* 2004, Chapter 6). The WAFWA recognizes four populations of greater sage-grouse in the Bi-State area but only two populations (North Mono Lake and South Mono Lake) had sufficient data to warrant analysis (Connelly *et al.* 2004, pp. 6-60, 6-61, 6-62). Essentially, the South Mono Lake population encompasses the South Mono PMU, while the North Mono Lake population encompasses the Bodie, Mount Grant, and Desert Creek–Fales PMUs. The authors reported that the North Mono Lake population displayed a significant negative trend from 1965 to 2003, and the South Mono Lake population displayed a non-significant positive trend over this same period (Connelly *et al.* 2004, pp. 6-69, 6-70).

In 2008, WAFWA conducted a similar trend analysis on these two populations using a different statistical method for the periods from 1965 to 2007, 1965 to 1985, and 1986 to 2007 (WAFWA 2008, Appendix D). The 2008 WAFWA analysis reports the trend for the North Mono Lake population, as measured by maximum male attendance at leks, was negative from 1965 to 2007 and 1965 to 1985 but variable from 1986 to 2007, and suggests an increasing trend beginning in about 2000. WAFWA's results for the South Mono Lake population suggest a negative trend from 1965 to 2007, a stable trend from 1965 to 1985, and a variable trend from 1986 to 2007, again suggesting a positive trend beginning around 2000. These two populations do not encompass the

Figure 4—Population Management Units (PMUs) and greater sage-grouse distribution within the Bi-State planning area, California and Nevada.

entire Bi-State area but do represent a large percentage of known leks. The two PMUs excluded from this analysis were the Pine Nut and White Mountains, which WAFWA delineates as separate populations that lacked sufficient data for analysis.

A new analysis by Garton *et al.* (*in press*, pp. 36, 37), also reports a decline in the North Mono Lake population from the 1965–1969 to 2000–2007 assessment periods, with no consistent long-term trend. In the South Mono Lake population, Garton *et al.* (*in press*, pp. 37, 38) report an increase in the 1965–1969 to 1985–1989 assessment periods but a decline in the 1985–1989 to 2000–2007 assessment periods, with no obvious trend. Garton *et al.* (in press, pp. 36, 38) report that the estimated average annual rate of change for both of these populations suggests that growth of these two populations has been, at times, both positive and negative.

The CDFG and NDOW annually conduct greater sage-grouse lek counts in the California and Nevada portions, respectively, of the Bi-State area. These lek counts are used by the CDFG and NDOW to estimate greater sage-grouse populations for each PMU in the Bi-State area. Low and high population estimates are derived by combining a corrected number of males detected on a lek, an assumed sex ratio of two females to one male, and two lek detection rates (intended to capture the uncertainty associated with finding leks). The lek detection rates vary by PMU but range between 0.75 and 0.95.

Beginning in 2003, the CDFG and NDOW began using the same method to estimate population numbers, and consequently, the most comparable population estimates for the entire Bi-State area start in 2003. Prior to 2003, Nevada survey efforts varied from year to year, with no data for some years, and inconsistent survey methodology. The CDFG methods for estimating populations of greater sage-grouse in California were more consistent than NDOW's prior to 2003. However, using population estimates for greater sage-grouse derived before 2003 could lead to invalid and unjustified conclusions given the variation in the number of leks surveyed, survey methodology, and population estimation techniques between the NDOW and CDFG. Therefore, we are presenting population numbers from 2003 to 2009. Population estimates derived from spring lek counts are problematic due to unknown or uncontrollable biases such as the true ratio of females to males or the percentage of uncounted leks. We provide this information in order to place into context what we consider to be a reasonable range as to the extent of the population in the Bi-State area as well as to demonstrate the apparent variability in annual estimates over the short term. For reasons described above we caution against assigning too much certainty to these results.

Spring population estimates are presented in Tables 11 and 12 for the South Mono, Bodie, Mount Grant, and Desert Creek–Fales PMUs (CDFG 2009, unpublished data; NDOW 2009, unpublished data). They also include population estimates for the Nevada portion of the Pine Nut PMU (NDOW 2009, unpublished data). However, they do not include population estimates for the White Mountains PMU or the California portion of the Pine Nut PMU. Due to the difficulty in accessing the White Mountains PMU, no consistent surveys have been conducted and it appears that birds are not present in the California portion of the Pine Nut PMU (Gardner 2006, pers. comm.).

TABLE 11—COMBINED SPRING POPULATION ESTIMATES FOR BI-STATE AREA GREATER SAGE-GROUSE. (SEE TEXT FOR CITATIONS.)

Survey year	Population estimate range
2003	2,820 to 3,181
2004	3,682 to 4,141
2005	3,496 to 3,926
2006	4,218 to 4,740
2007	3,287 to 3,692
2008	2,090 to 2,343
2009	2,712 to 3,048

TABLE 12—POPULATION MANAGEMENT UNIT (PMU) SIZE, OWNERSHIP AND ESTIMATED SUITABLE GREATER-SAGE-GROUSE HABITAT, AND ESTIMATED GREATER SAGE-GROUSE POPULATION FOR 2009. (SEE TEXT FOR DETAILS AND CITATIONS.)

Population Management Unit (PMU)	Total Size acres (ha)	Percent Federal Land	Estimated Habitat acres (ha)	Estimated Population (2009)
Pine Nut	574,373 (232,441)	72	233,483 (94,488)	89–107
Desert Creek-Fales	567,992 (229,859)	88	191,985 (77,694)	512–575
Mount Grant	699,079 (282,908)	90	254,961 (103,180)	376–427
Bodie	349,630 (141,491)	74	183,916 (74,428)	829–927
South Mono	579,483 (234,509)	88	280,492 (113,512)	906–1,012
White Mountains	1,753,875 (709,771)	97	418,056 (169,182)	NA

As shown in Table 12, Federal lands comprise the majority of the area within PMUs. Although other land ownership is small in comparison, these other lands contain important habitat for greater sage-grouse life cycle requirements. In particular, mesic areas that provide important brood rearing habitat are often on private lands.

Movement, Habitat Use, Nest Success, and Survival

Casazza *et al.* (2009, pp. 1-49) conducted a 3–year study on greater sage-grouse movements in the Bi-State area. The researchers radio-marked 145 birds, including 104 females and 41 males, in Mono County within the Desert Creek–Fales, Bodie, White Mountains, and South Mono PMUs (Casazza *et al.* 2009, p. 6). The greatest distance moved by radio-marked birds between any two points is as follows: 29 percent moved from 0 to 8 km (0 to 5 mi); 41 percent moved from 8 to 16 km (5 to 10 mi); 25 percent moved from 16 to 24 km (10 to 15 mi); 4 percent moved from 24 to 32 km (15 to 20 mi); and 1 percent moved greater than 32 km (20 mi).

Female greater sage-grouse home range size ranged from 2.3 to 137.1 km^2 (0.9 to 52.9 mi^2), with a mean home range size of 38.6 km^2 (14.9 mi^2) (Overton 2006, unpublished data). Male greater sage-grouse home range size ranged from 6.1 to 245.7 km^2 (2.3 to 94.9 mi^2) with a mean home range size of 62.9 km^2 (24.1 mi^2) (Overton 2006, unpublished data). Annual home ranges were largest in the Bodie PMU and smallest in the Parker Meadows area of the South Mono PMU and the California portion of the Desert Creek–Fales PMU.

The data from more than 7,000 telemetry locations, representing the 145 individuals indicate movement between populations in the Bi-State area is limited. No birds caught within the White Mountains, South Mono, or Desert Creek–Fales PMUs made movements outside their respective PMUs of capture. Previously, the NDOW tracked a female greater sage-grouse radio-marked near Sweetwater Summit in the Nevada portion of the Desert Creek–Fales PMU to Big Flat in the northern portion of the Bodie PMU, suggesting possible interaction between these PMUs. Also, some birds caught in the Bodie PMU made seasonal movements on the order of 8 to 24 km (5 to 15 mi) east into Nevada and the adjacent Mount Grant PMU. Within the Bi-State area some known bird movements would be classified as migratory, but the majority of radio-marked individuals have not shown movements large enough to be characterized as migratory (Casazza *et al.* 2009, p. 8).

In association with Casazza *et al.* (2009), Kolada (2007) conducted a study examining nest site selection and nest survival of greater sage-grouse in Mono County, These greater sage-grouse selected nest sites high in shrub cover (42 percent on average), and these shrubs were often species other than sagebrush (i.e., bitterbrush (*Purshia tridentata*)) (Kolada 2007, p. 18). The reported amount of shrub cover was not outside the normal range found in other studies (Connelly *et al.* 2000a, p. 970). However, there was a large contribution of non-sagebrush shrubs to greater sage-grouse nesting habitat in Mono County. There was no evidence that greater sage-grouse hens were selecting for nest sites with greater residual grass cover or height as compared to random sites. Overall nest success among birds in Mono County during the 3–year study (2003–2005) appears to be among the highest of any population rangewide (Kolada 2007, p. 70). However, nest success in Long Valley (South Mono PMU) was substantially lower than for either the Bodie or Desert Creek–Fales PMUs.

Also in association with Casazza *et al.* (2009), Farinha *et al.* (2008, unpublished data) found that survival of adults was lowest in the northern Bi-State area and highest in Long Valley. Near Sonora Junction, California (Desert Creek–Fales PMU) and in the Bodie Hills (Bodie PMU), adult survival was 4 and 18 percent, respectively. Sedinger *et al.* (*unpublished data*, p. 12) derived a similar adult survival estimate (16 percent) for an immediately adjacent area in Nevada. Survival estimates at these three locations are unusually low (Sedinger *et al.* unpublished data, p. 12). In Long Valley, Farinha *et al.* (2008, unpublished data) estimated adult survival at 53 percent, which is more consistent with annual survival estimates reported in other portions of the species' range.

Summary of Factors Affecting the Bi-State DPS of the Greater Sage-Grouse

Section 4 of the Act (16 U.S.C. 1533) and implementing regulations at 50 CFR part 424, set forth procedures for adding species to the federal Lists of Endangered and Threatened Wildlife and Plants. In making this finding, we summarize below information regarding the status and threats to the Bi-State DPS of the greater sage-grouse in relation to the five factors provided in section 4(a)(1) of the Act. Under section (4) of the Act, we may determine a species to be endangered or threatened on the basis of any of the following five factors: (A) Present or threatened destruction, modification, or curtailment of habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. We evaluated whether threats to the Bi-State area greater sage-grouse DPS may affect its survival. Our evaluation of threats is based on information provided in the petitions, available in our files, and other sources considered to be the best scientific and commercial information available including published and unpublished studies and reports.

Our understanding of the biology, ecology, and habitat associations of the Bi-State DPS of the greater sage-grouse, and the potential effects of perturbations such as disease, urbanization, and infrastructure development on this population, is based primarily on research conducted across the range of the entire greater sage-grouse species. The available information indicates that the members of the species have similar physiological and behavioral characteristics, and consequently similar habitat associations. We believe the potential effects of specific stressors on the Bi-State DPS of the greater sage-grouse are the same as those described in the GSG finding, above. To avoid redundancy, the descriptions of these effects are omitted below and further detail and citations may be found in the corresponding analysis in the GSG finding, above.

The range of the Bi-State DPS of the greater sage-grouse is roughly 3 percent of the area occupied by the entire greater sage-grouse species, and the relative impact of effects caused by specific threats may be greater at this smaller scale. We have considered these differences of scale in our analysis and our subsequent discussion is focused on the degree to which each threat influences the Bi-State DPS of the greater sage-grouse. Individual threats described within Factors A through E below are not all present across the entire Bi-State area. However, the influence of each threat on specific populations may influence the resiliency and redundancy of the entire Bi-State greater sage-grouse population.

Factor A: The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range.

Urbanization

Changing land uses have and continue to occur in the Bi-State area.

Where traditional private land use was primarily farming and ranching operations, today, some of these lands are being sold and converted to low-density residential housing developments. About 8 percent of the land base in the Bi-State area is privately owned. A 2004 threat analysis recognized urban expansion as a risk to greater sage-grouse in the Pine Nut, Desert Creek–Fales, Bodie, and South Mono PMUs (Bi-State Plan 2004, pp. 24, 47, 88, 169). The CDFG reports that private lands have been sold and one parcel was recently developed on Burcham Flat within the Desert Creek–Fales PMU (CDFG 2006). Additionally, a planned subdivision of a 48 ha (120 ac) parcel that is in close proximity to the Burcham Flat lek, 1 of 3 remaining leks in the California portion of the Desert Creek–Fales PMU, is currently under review by the County of Mono, California. The subdivision would replace a single ranch operation with three private residences.

Sagehen (16.2 ha (40 ac)) and Gaspipe (16.2 ha (40 ac)) Meadows located in the South Mono PMU have recently been affected by development. Also, Sinnamon (~485 ha, ~1,200 ac) and Upper Summers Meadows (~1,214 ha; ~3,000 ac) located in the Bodie PMU are currently for sale (Taylor 2008, pers. comm.). Each of these private parcels is important to greater sage-grouse because of the summer brood-rearing habitat they provide (Taylor 2008, pers. comm.). The NDOW is concerned that the urbanization or the division of larger tracts of private lands into smaller ranchettes will adversely affect greater sage-grouse habitat in the Nevada portion of the Pine Nut and Desert Creek–Fales PMUs (NDOW 2006, p. 4). The NDOW reported that expansions of Minden, Gardnerville, and Carson City, Nevada, are encroaching into the Pine Nut Range (within the Pine Nut PMU) and that housing development in Smith Valley and near Wellington, Nevada, has fragmented and diminished greater sage-grouse habitats in the north portion of the Desert Creek–Fales PMU (NDOW 2006, p. 4).

Development of private lands is known to impact greater sage-grouse habitat (Connelly *et al.* 2004, pp. 7-25, 7-26), and federal and state agencies may actively work to purchase parcels important for greater sage-grouse conservation. Recently, the State of California purchased a 470 ha (1,160 ac) parcel in the Desert Creek–Fales PMU comprising the largest contiguous private land parcel in the California portion of the PMU.

When private lands adjacent to public lands are developed, there can be impacts to greater sage-grouse on the public lands. Approximately 89 percent of the land contained within the Bi-State area is federally managed land, primarily by the USFS and BLM. The BLM and USFS manage public lands under federal laws that provide for multiple-use management, which allows a number of actions that are either detrimental or beneficial to sage-grouse (Bi-State Plan 2004). The Bi-State Plan (2004, pp. 24, 88) reported within the Pine Nut and Bodie PMUs, habitat loss and fragmentation associated with land use change and development is not restricted to private lands. Rights-of-way (ROW) across public lands for roads, utility lines, sewage treatment plants, and other public purposes are frequently granted to support development activities on adjacent private parcels.

Based on location data from radio-marked birds in the Desert Creek–Fales, Bodie, and South Mono PMUs, greater sage-grouse home ranges consist of a combination of public and privately owned lands (Casazza 2009, p. 9). In the Desert Creek–Fales PMU, use of private lands was most pronounced near Burcham and Wheeler Flats. Home ranges of these individuals encompassed between 10 and 15 percent private lands, depending on the season (Casazza *et al.* 2009, p. 19). In the Bodie PMU radio-marked birds were found to use private lands between 10 and 20 percent of the time, with use most pronounced during the summer and winter months (Casazza 2009, p. 27). In the South Mono and White Mountains PMUs, use of private lands was greatly restricted. We have limited quantitative data for birds breeding in the Nevada portion of the Bi-State area. However, some greater sage-grouse breeding in the Bodie PMU moved to wintering habitat on private land in Nevada on the adjacent Mount Grant PMU. Also, private lands in the Nevada portion of the Desert Creek–Fales PMU and the Mount Grant PMU are used by sage-grouse throughout the year, especially during the late summer brood-rearing period (Espinosa 2008, pers. comm.).

The Town of Mammoth Lakes, California, located in the southern extent of the Bi-State planning area recently adopted measures that will allow for more development on private lands (Town of Mammoth Lakes General Plan 2007). Increased indirect effects to greater sage-grouse habitat are expected due increases in the human population in the area.

The proposed expansion of the Mammoth Yosemite Airport is located in occupied greater sage-grouse habitat within the South Mono PMU. Approximately 1.6 ha (4 ac) of land immediately surrounding the airport is zoned for development. Also, the Federal Aviation Administration (FAA) recently resumed regional commercial air service at the Airport with two winter flights per day beginning in 2008 and potentially increasing to a maximum of eight winter flights per day by 2011 (FAA 2008, ES-1). The Mammoth Yosemite Airport formerly had regional commercial air service from 1970 to the mid-1990's (FAA 2008, p. 1-5), and it currently supports about 400 flights per month of primarily single-engine, private aircraft (Town of Mammoth Lakes 2005, p. 4-204). All greater sage-grouse in the Long Valley portion of the South Mono PMU occur in close proximity to the Airport and have been exposed to commercial air traffic in the past, and are currently exposed to private air traffic. Effects of reinstating commercial air service at the Mammoth Yosemite Airport on greater sage-grouse are unknown as the level of commercial flight traffic these birds may be exposed to is undetermined as is the impact this exposure will have on population dynamics.

The Benton Crossing landfill in Mono County is located north of Crowley Lake in Long Valley (South Mono PMU) on a site leased from the LADWP. Common ravens (*Corvus corax*) and California gulls (*Larus californicus*) are known to heavily use the facility (Coates 2008, pers. comm.), although no specific surveys of either species' abundance have been conducted. The influence these known predators have on the population dynamics of the South Mono PMU is not known. However, Kolada (2007, p. 66) reported that nest success in Long Valley was significantly lower in comparison to other populations within the Bi-State planning area. This result may be attributable to the increased avian predators subsidized by landfill operations (Casazza 2008, pers. comm.).

Summary: Urbanization

Development of private lands for housing and the associated infrastructure within the Bi-State area is resulting in the destruction and modification of habitat of the Bi-State area greater sage-grouse DPS. The threat of development is greatest in the Pine Nut, Desert Creek–Fales, and Bodie PMUs, where development is, and will likely continue to impact Bi-State area greater sage-grouse DPS use of specific seasonal sites. The small private holdings in the Bi-State area are typically associated with mesic meadow or spring habitats that play an important

role in greater sage-grouse life history. Greater sage-grouse display strong site fidelity to traditional seasonal habitats and loss of specific sites can have pronounced population impacts. The influence of land development on the population dynamics of greater sage-grouse in the Bi-State area is greater than a simple measure of spatial extent. As noted above, resumption of commercial air service at the Mammoth Yosemite Airport, combined with the construction of an adjacent business park, will likely affect greater sage-grouse in the South Mono PMU through increasing aircraft and human activity in or near sage-grouse habitat.

Development of public and private lands for a variety of purposes, including residential homes and ROWs to support associated infrastructure can negatively affect sage-grouse and their habitat, and while these threats may not be universal, localized areas of impacts are anticipated. Based on the data available, direct and indirect effects of urbanization have exerted and will continue to exert a negative influence in specific portions of greater sage-grouse range in the Bi-State area. This is already especially apparent in the northern portion of the range of the Bi-State DPS of the greater sage-grouse, in the Pine Nut, Desert Creek–Fales, and Bodie PMUs (NDOW 2006, p. 4; Bi-State Plan 2004, pp. 24, 88).

Infrastructure - Fences, Powerlines, and Roads

Fences are considered a risk to greater sage-grouse in all Bi-State PMUs (Bi-State Plan 2004, pp. 54, 80, 120, 124, 169). As stated in the December 19, 2006, 90–day finding (71 FR 76058), the BLM Bishop Field Office reported increased greater sage-grouse mortality and decreased use of leks when fences were in close proximity. Known instances of collision, and the potential to fragment and degrade habitat quality by providing movement pathways and perching substrates for invasive species and predators have been cited.

Fences can also provide a valuable rangeland management tool. If properly sited and designed, fencing may ultimately improve habitat conditions for greater sage-grouse. Near several leks in the Long Valley area of the South Mono PMU, the BLM and LADWP are currently using ''let down'' fences as a means of managing cattle. This design utilizes permanent fence posts but allows the horizontal wire strands to be effectively removed (let down) during the greater sage-grouse breeding season or when cattle are not present. While this method does not ameliorate all negative aspects of fence presence such as perches for avian predators, it does reduce the likelihood of collisions. Currently, data on the total extent (length and distribution) of existing fences and the amount of new fences being constructed are not available for the Bi-State area.

Powerlines occur in all Bi-State PMUs and are a known threat to the greater sage-grouse, but the degree of effect varies by location. In the Pine Nut PMU, powerlines border the North Pine Nut lek complex on two sides (Bi-State Plan 2004, p. 28). An additional line segment to the northwest of this complex is currently undergoing review by the BLM Carson City District. If this additional line is approved, powerlines will surround the greater sage-grouse habitat in the area. Of the four leks considered active in the area, the distance between the leks and the powerlines ranges from approximately 1.2 to 2.9 km (0.74 to 1.8 mi). Additionally, one line currently bisects the relatively limited nesting habitat in the area. Proximity to powerlines is negatively associated with greater sage-grouse habitat use, with avoidance of otherwise suitable breeding habitat (as indicated by the location of active leks), which may be the result of predator avoidance (e.g., ravens and raptors) (Bi-State Plan 2004, p. 81; and see *Powerlines* discussion under Factor A in the GSG finding above).

In the Desert Creek–Fales PMU, powerlines are one of several types of infrastructure development that impact greater sage-grouse through displacement and habitat fragmentation (Bi-State Plan 2004, p. 54). Recent declines in populations near Burcham and Wheeler Flats in the California portion of the Desert Creek–Fales PMU may be related to construction of powerlines and associated land use activities (Bi-State Plan 2004, p. 54). This area continues to see urban development which will likely require additional distribution lines. In the Bodie PMU, utility lines are a current and future threat that affects multiple sites (Bi-State Plan 2004, p. 81). In northern California, utility lines have a negative effect on lek attendance and strutting activity. Radio-tagged greater sage-grouse loss to avian predation increased as the distance to utility lines decreased (Bi-State Plan 2004, p. 81). Common ravens are a capable nest predator and often nest on power poles or are found in association with roads. The Bi-State Plan also identifies numerous small-distribution utility lines in the Bodie PMU that are likely negatively affecting greater sage-grouse. The plan references the expected development of new lines to service private property developments. The BLM Bishop Field Office reported reduced activity at one lek adjacent to a recently developed utility line and suggested this may have been influenced by the development (Bi-State Plan 2004, p. 81). Since 2004, however, numbers at this lek have rebounded. Currently, there are no high-voltage utility lines in the Bodie PMU, nor are there any designated corridors for this use in existing land use plans (Bi-State Plan 2004, p. 82).

A high-voltage powerline currently fragments the Mount Grant PMU from north to south, with two to three additional smaller distribution lines extending from Hawthorne, Nevada, west to the California border. The larger north–south trending powerline is sited in a corridor that was recently adopted as part of the West-wide Energy Corridor Programmatic EIS (BLM/USFS 2009), thus future development of this corridor is anticipated. There are two leks that likely represent a single complex in proximity to this line segment that have been sporadically active over recent years. Whether this variation in active use is due to the powerline is not clear. Additionally, there is strong potential for geothermal energy development in the Mount Grant PMU that will require additional distribution lines to tie into the existing electrical grid (see *Renewable Energy Development* below; RETAAC 2007). Of significant concern will be additional distribution lines in proximity to the historic mining district of Aurora, Nevada, which supports the largest lek in the Mount Grant PMU and occurs about 2.5 km (1.5 mi) from the main north-south line.

The Bi-State Plan (2004, p. 169) mentions three transmission lines in the South Mono PMU that may be impacting birds in the area on a year round basis including three leks that are in proximity to existing utility lines. Future geothermal development may also result in expansion of transmission lines in the South Mono PMU (Bi-State Plan 2004, p. 169). Threats posed by powerlines to the White Mountains PMU are not currently imminent, although future development is possible.

An extensive road network occurs throughout the Bi-State area. The type of road varies from paved, multilane highways to rough jeep trails but the majority of road miles are unpaved, dirt two-track roads. Traffic volume varies significantly, as does individual population exposure. For a comprehensive discussion of the effects of roads on greater sage-grouse see *Roads* under Factor A in the GSG

finding above. In the Desert Creek–Fales PMU, roads are a risk to greater sage-grouse (Bi-State Plan 2004, p. 54). All leks in this PMU are in close proximity to dirt two-track roads. Seven of eight consistently occupied leks in recent years are in relatively close proximity (< 2.5 km (1.5 mi)) to well- traveled highways. Although abundant, roads were not presented as a specific risk factor for the Pine Nut, Bodie, or Mount Grant PMUs during the development of their respective risk assessments (Bi-State Plan 2004). Large portions of these PMUs are not accessible, due to heavy winter snow until early summer after the completion of the breeding season and many of the roads are not frequently traveled. However, several leks in the Bodie PMU are in proximity to well-maintained and traveled roads.

In the South Mono PMU, roads are recognized as a risk factor that affects greater sage-grouse habitat and populations (Bi-State Plan 2004, p. 169). A variety of roads in this area have access to many significant lek sites. In Long Valley, lek sites are accessible via well maintained gravel roads. Recreational use of these areas is high and road traffic is substantial. Two lek sites that were in close proximity (< 300 m (1,000 ft)) to Highway 120 are thought to be extirpated although the exact cause of extirpation is unknown. Roads in the White Mountains PMU may negatively impact greater sage-grouse populations and their habitats, and construction of new roads in this PMU will fragment occupied or potential habitat for the species (Bi-State Plan 2004, pp. 120, 124).

Although greater sage-grouse have been killed due to vehicle collisions in the Bi-State area (Wiechmann 2008, p. 3), the greater threat with respect to roads is their influence on predator movement, invasion by nonnative annual grasses, and human disturbance. Currently in the Bi-State area, all federal lands except those managed by the BLM's Carson City District Office have restrictions limiting vehicular travel to designated routes. The lands where these restrictions apply account for roughly 1.6 million ha (4 million ac) or 86 percent of the land base in the Bi-State area. Both the Inyo and Humboldt–Toiyabe National Forests have recently mapped existing roads and trails on Forest Lands in the Bi-State area as part of a USFS Travel Management planning effort including identification of designated routes (Inyo National Forest 2009; Humboldt–Toiyabe National Forest 2009). These planning efforts will most directly influence the South Mono, Desert Creek–Fales, and Mount Grant PMUs; however, the degree to which they will influence greater sage-grouse populations is unclear. While the planning effort of the Inyo National Forest has, and the planning effort of the Humboldt-Toiyabe National Forest will likely add many miles of unauthorized routes to the National Forest System, these routes have already been in use for decades and any future negative impacts will be the result of an increase in use of these routes.

Starting in 2005, the BLM's Bishop Field Office implemented seasonal closures of several roads in proximity to three lek complexes in the Long Valley area of the South Mono PMU during the spring breeding season as part of a greater sage-grouse management strategy (BLM 2005c, p. 3). The Field Office is also rehabilitating several miles of redundant routes to consolidate use and minimize habitat degradation and disturbance for these same lek complexes.

Summary: Infrastructure - Fences, Powerlines, and Roads

Existing fences, powerlines, and roads fragment and degrade greater sage-grouse habitat, and contribute to direct mortality through collisions. Additionally, new fences, powerlines, and roads increase predators and invasive plants that increase fire risk and or displace native sagebrush vegetation. In the Bi-State area, all of these linear features adversely affect each of the PMUs both directly and indirectly to varying degrees. However, we do not have consistent and comparable information on miles of existing or new fences, powerlines and roads, or densities of these features within PMUs for the Bi-State area as a whole. Wisdom *et al.* (*in press*, p. 58) reported that across the entire range of the greater sage-grouse species, the mean distance to highways and transmission lines for extirpated populations was approximately 5 km (3.1 mi) or less. In the Bi-State area between 35 and 45 percent of annually occupied leks, which are indicative of the presence of nesting habitat, are within this distance to state or federal highways and between 40 and 50 percent are within this distance to existing transmission lines.

Lek counts suggest that greater sage-grouse populations in Long Valley, and to a lesser degree Bodie Hills, have been relatively stable over the past 15 years. The remaining populations in the Bi-State area appear considerably less stable. Research on adult and yearling survival suggests that annual survival is relatively low in the northern half of the Bi-State area (Farinha 2008, unpublished data). Annual survival was lowest in birds captured in association with the Wheeler and Burcham Flat leks in the California portion of the Desert Creek–Fales PMU, an area in very close proximity to Highway 395 and several transmission lines. Research conducted on nest success, however, shows an opposite trend from that of adult survival, with overall nest success relatively high in the northern half of the Bi-State area and lower in the southern half (Kolada 2007, p. 52). In Long Valley, where nest success was lowest, the combination of linear features (infrastructure) and an increased food source (Benton Crossing landfill) for avian predators may be influencing nest survival. Given current and future development (based on known energy resources), the Mount Grant, Desert Creek–Fales, Pine Nut, and South Mono PMUs are likely to be the most directly influenced by new powerlines and associated infrastructure.

Greater sage-grouse in the Bi-State area have been affected by roads and associated human disturbance for many years. The geographic extent, density, type, and frequency of disturbance have changed over time, and the impact has likely increased with the proliferation of off-highway vehicles. There are no indications that the increasing trend of these activities will diminish in the near future.

Mining

Mineral extraction has a long history throughout the Bi-State area. Currently, the PMUs with the greatest exposure are Bodie, Mount Grant, Pine Nut, and South Mono (Bi-State Plan 2004, pp. 89, 137, 178). Although mining represents a year round risk to greater sage-grouse, direct loss of key seasonal habitats or population disturbances during critical seasonal periods are of greatest impact. In the Bodie PMU, mining impacts to the ecological conditions were most pronounced in the late 1800's and early 1900's when as many as 10,000 people inhabited the area. The area is still open to mineral development, and exploration is likely to continue into the future (Bi-State Plan 2004, pp. 89–90). In the Bodie Hills, current mining operations are restricted to small-scale gold and silver exploration and sand and gravel extraction activities with limited impacts on greater sage-grouse (Bi-State Plan 2004, p. 90). An exploratory drilling operation is currently authorized in the Bodie Hills near the historic Paramount Mine, approximately 8 km (5 mi) north of Bodie, California. The proposed action may influence movement and use of

important seasonal habitats near Big Flat. If subsequent development occurs, restricted use of or movement through this area will adversely influence connectivity between the Bodie and Mount Grant PMUs.

The Mount Grant and Pine Nut PMUs also have a long history of mining activity. Activity in the Mount Grant PMU has typically consisted of open pit mining. Two open pit mines exist, one of which is currently active. It is likely that mining will continue and may increase during periods when prices for precious metals are high, negatively effecting the sage-grouse populations in those areas. Mining in the Mount Grant PMU is largely concentrated around the Aurora historic mining district. This area contains the largest remaining lek in the PMU, which is located on private land. In the Pine Nut PMU, most mining activity is confined in woodland habitat but there is some overlap with sage-grouse habitats.

Summary: Mining

The effect of mining is not evenly distributed throughout the Bi-State area. It is greatest in the Mount Grant and Bodie PMUs where mining impacts to habitat may decrease the persistence of greater sage-grouse in the Mount Grant PMU Aurora lek complex area. This area represents a significant stronghold for the Mount Grant PMU and serves as a potential connection between breeding populations in the Bodie Hills to the west with breeding populations occurring further east in the Wassuk Range located on the eastern edge of the Mount Grant PMU. Further mineral extraction in either of these PMUs will negatively influence the spatial extent of the breeding population occurring in the Bodie Hills and the long term persistence of these populations.

Energy Development

Although energy development and the associated infrastructure was identified as a risk for greater sage-grouse occurring in the Bi-State area (Bi-State Plan 2004, pp. 30, 178), the risk assessment preceded the current heightened interest in renewable energy and underestimated the threats to the species. Several locations in the Bi-State area have suitable wind resources, but currently only the Pine Nut Mountains have active leases that overlap sage-grouse distribution. Approximately 3,696 ha (9,135 ac) have been leased from the BLM Carson City District and are being evaluated for wind development. The areas under lease are on the main ridgeline of the Pine Nut Mountains extending from Sunrise Pass near the Lyon and Douglas County line south to the Mount Siegel area. The area is a mix of shrub and woodland habitats containing year-round greater sage-grouse habitat. The ridgeline occurs between the north and south greater sage-grouse populations in the Pine Nut PMU. The area was recently designated as a renewable energy ''wind zone'' by Nevada Governor Jim Gibbons' Renewable Energy Transmission Access Advisory Committee (RETAAC; RETAAC 2007, Figure 2). Development of the Pine Nut area will have a significant impact on the connectivity within this small population and greatly restrict access to nesting and brooding habitat. Additional areas located in sage-grouse habitat may have suitable wind resources and could be developed in the future.

In the South Mono PMU there are two geothermal plants located on private land immediately east of U.S. 395 at Casa Diablo. These are the only operating geothermal plants in the Bi-State area. Within the South Mono PMU about 3,884 ha (9,600 ac) are under geothermal lease. The leased areas are located to the west of U.S. 395 and immediately north of Highway 203 and largely outside of occupied sage-grouse habitat.

Within the Desert Creek–Fales PMU, about 2,071 ha (5,120 ac) on the north end of the Pine Grove Hills near Mount Etna are leased for geothermal development. The leases in this area are valid through 2017. Several locations within the Mount Grant PMU are also under current leases and several more areas are currently proposed for leasing. Based on location and vegetation community, two of the leased areas in the Mount Grant PMU are of great importance to sage-grouse. Four sections (1,035 ha, 2,560 ac) are leased approximately 1.6–4.8 km (1–3 mi) southeast of the confluence between Rough Creek and the East Walker River near the Lyon and Mineral County line on lands managed by the USFS. This area is considered year-round greater sage-grouse habitat with from one to three active leks in proximity. Additionally, approximately 13 sections (3,366 ha, 8,320 ac) are leased around the Aurora historic mining district near the Nevada and California border. Much of this area is dominated by pinyon–juniper woodlands, but at least three sections (776 ha, 1,920 ac) contain sagebrush communities and there is one known lek in close proximity. The leased sections within the Desert Creek–Fales and Mount Grant PMUs also fall within the boundary delineated for geothermal development proposed by RETAAC (RETAAC 2007, Figure 2).

Summary: Energy Development

The likelihood of renewable energy facility development in the Bi-State area is high. There is strong support for energy diversification in both Nevada and California, and the energy industry considers the available resources in the area to warrant investment (RETAAC 2007, p. 8). Greater sage-grouse habitat in the Pine Nut and Mount Grant PMUs will likely be most affected by facility and infrastructure development. Given this anticipated development, additional fragmentation and isolation as well as some degree of range contraction will occur that will significantly affect the Pine Nut and Mount Grant PMUs. Renewable energy development is not evenly distributed across the entire Bi-State area, but it will likely be a significant threat to populations in the Pine Nut and Mount Grant PMUs.

Grazing

In the Bi-State area, all PMUs are subject to livestock grazing with the majority of ''public'' allotments allocated to cattle and sheep (Bi-State Plan 2004). Determining how grazing impacts greater sage-grouse habitat and populations is complicated. There are data to support both beneficial and detrimental aspects of grazing (Klebenow 1981, p. 122; Beck and Mitchell 2000, p. 993), suggesting that the risk of livestock grazing to greater sage-grouse is dependent on site-specific management.

Kolada (2007, p. 52) reports nest success of greater sage-grouse in the Bi-State area on average to be as high as any results reported across the range of the species. However, nest success is varied among PMUs, and residual grass cover did not appear to be as significant a factor to nest success as in other western U.S. locations. These findings suggest that grazing in the Bi-State area may not be strongly influencing this portion of the bird's life history.

Important mesic meadow sites are relatively limited outside of Long Valley and the South Mono PMU, especially north of Mono Lake (Bi-State Plan 2004, pp. 17, 65, 130). This limitation may influence greater sage-grouse population growth rates. Although most of the grazed lands in the Bi-State area are managed by the BLM and USFS under rangeland management practices and are guided by agency land use plans, much of the suitable mesic habitats are located on private lands. Given their private ownership assessing the condition of these sites is difficult and conditions are not well known. Although there are federal grazing

allotments that are exhibiting adverse impacts from livestock grazing, such as the Churchill Allotment in the Pine Nut PMU (Axtell 2008, pers. comm.), most allotments in the Bi-State area are classified as being in fair to good condition (Axtell 2008, pers. comm.; Murphy 2008, pers. comm.; Nelson 2008, pers. comm.). We have no information indicating how allotment condition classifications used by the BLM and USFS correlate with greater sage-grouse population health.

Feral horses are present in the Bi-State area. Connelly *et al.* (2004, pp. 7-36–7-37) stated that areas occupied by horses have lower grass, shrub, and total vegetative cover and that horse alteration of spring or other mesic areas may be a concern with regard to greater sage-grouse brood rearing. The most significant impact from feral horses has occurred in the Mount Grant and Pine Nut PMUs (Axtell 2008, pers. comm.). The Bodie PMU has also been impacted by feral horses and these animals pose a risk of disturbance to the 7-Troughs lek population (Bi-State Plan 2004, pp. 86–87). The intent of the agencies involved is to maintain horse numbers at or below those established for the herd management areas (HMA) and wild horse territories (WHT). In 2003, the BLM captured and removed 26 horses from the Powell Mountain WHT located in the Mount Grant PMU and 7 horses from the Bodie PMU. Currently there are relatively low numbers of horses (10 to 20) in the Bodie PMU. The Bodie Hills have no defined HMA/WHT but the horses present are likely coming from the Powell Mountain WHT located in the Mount Grant PMU (Bi-State Plan 2004, pp. 86–87). In 2007, the USFS took an additional 87 horses off the Powell Mountain WHT (Murphy 2008, pers. comm.). The herd management level set for the Powell Mountain WHT is 35 individuals. Although management of feral horse populations is an ongoing issue, local land managers consider it to be controllable given sufficient funding and public support.

Summary: Grazing

There are localized areas of habitat degradation attributable to grazing that indirectly and cumulatively affect greater sage-grouse. Overall population estimates, while variable from year-to-year, show no discernable trend attributable to grazing. The impact on ecosystems by different ungulate taxa may have a combined negative influence on greater sage-grouse habitats (Beever and Aldridge in press, p. 20). Cattle, horses, mule deer, and antelope each use the sagebrush ecosystem somewhat differently and the combination of multiple species may produce a different result than simply more of a single species. Greater sage-grouse habitat in the Pine Nut PMU, as well as limited portions of the Bodie PMU, is affected by grazing management practices and has a negative effect on sage-grouse in those areas. Overall, the available data do not provide evidence that grazing by domestic or feral animals is a major impact to habitat of greater sage-grouse throughout the entire Bi-State area. However, the loss or degradation of habitat due to grazing contributes to the risk of extirpation of some local populations, which in turn contributes to increased risk to the persistence of the Bi-State DPS.

Fire

As discussed above, in the GSG finding, changes in the fire ecology that result in an altered wildfire regime are a present and future risk in all PMUs in the Bi-State area (Bi-State Plan 2004). A reduction in fire occurrence has facilitated the expansion of woodlands into montane sagebrush communities. In the Pine Nut and Desert Creek–Fales PMUs this has resulted in a loss of sagebrush habitat (Bi-State Plan 2004, pp. 20, 39), while in other locations such as the Bodie and Mount Grant PMUs the most significant impact of conifer expansion is the additional fragmentation of sage-grouse habitat and isolation of the greater sage-grouse populations (Bi-State Plan 2004, pp. 95-96, 133).

Invasion by annual grasses (e.g., *Bromus tectorum*) can lead to a shortening of the fire frequency that is difficult to reverse. Often invasive species become established or become apparent only following a fire or similar disturbance event. In the Bi-State area, there has been little recent fire activity (Finn *et al.* 2004, *http://wildfire.cr.usgs.gov/firehistory/data.html*). One exception is in the southern portion of the Pine Nut PMU where *B. tectorum* has readily invaded a recent burn in the Minnehaha Canyon area. In 2007, the Adrian Fire burned about 5,600 ha (14,000 ac) of important nesting habitat at the north end of the Pine Nut PMU. Although there does appear to be native grass establishment in the burn, *B. tectorum* is present and recovery of this habitat will likely be slow or impossible (Axtell 2008, pers. comm.). In 1996, a wildfire burned in the center of the Pine Nut PMU, in important brood rearing habitat. The area is recovering and has little invasive annual grass establishment. However, after 15 years the burned area has very limited sagebrush cover. While birds still use the meadow habitat, the number of individuals in the Pine Nut PMU is small. It is not known to what degree this loss of habitat has influenced population dynamics in the area but it is likely that it has and will continue to be a factor in the persistence of the Pine Nut population given its small size. Across the remainder of the Bi-State area wildfires occur on an annual basis, however, impacts to sagebrush habitats have been limited to date. Most species of sagebrush are killed by fire (West 1983, p. 341; Miller and Eddleman 2000, p. 17; West and Young 2000, p. 259), and historic fire-return intervals were as long as 350 years, depending on sagebrush type and environmental conditions (Baker in press, p. 16). Natural sagebrush recolonization in burned areas depends on the presence of adjacent live plants for a seed source or on the seed bank, if present (Miller and Eddleman 2000, p. 17), and requires decades for full recovery.

Summary: Fire

Within the Bi-State area, wildfire is a potential threat to greater sage-grouse habitat in all PMUs. To date few large landscape scale fires have occurred and we have not yet seen changes to the fire cycle (e.g., shorter) due to invasion by nonnative annual grasses. The BLM and USFS manage the area under what is essentially a full-suppression fire-fighting policy given adequate resources. Based on the available information, wildfire is not currently a significant threat to the Bi-State DPS of the greater sage-grouse. However, the future threat of wildfire, given the fragmented nature and small size of the populations within the DPS, would have a significant effect on the overall viability of the DPS based on its effects on the habitat in the Pine Nut PMU.

Invasive Species, Noxious Weeds, and Pinyon-Juniper Encroachment

A variety of nonnative, invasive plant species are present in all PMUs that comprise the Bi-State area, with *Bromus tectorum* (cheatgrass) being of greatest concern. (For a general discussion on the effects of non-native and invasive plant species, please see *Invasive plants* under Factor A in the GSG finding above).

Wisdom *et al.* (2003, pp. 4-3 to 4-13) assessed the risk of *Bromus tectorum* displacement of native vegetation for Nevada and reported that 44 percent of existing sagebrush habitat is either at moderate or high risk of displacement and correspondingly 56 percent of sagebrush habitat is at low risk of displacement. In conjunction with Wisdom *et al.* (2003), Rowland *et al.*

(2003, p. 40) found that 48 percent of greater sage-grouse habitat on lands administered by the BLM Carson City Field Office is at low risk of *B. tectorum* replacement, about 39 percent is at moderate risk, and about 13 percent is at high risk. Both assessments, however, included large portions of land outside the Bi-State area. Peterson (2003), in association with the Nevada Natural Heritage Program, estimated percent cover of *B. tectorum* in approximately the northern half of the Bi-State area using satellite data. Land managers and this satellite data assessment indicate that *B. tectorum* is present throughout the Bi-State area but percent cover is low. Conversion to an annual grass dominated community is limited to only a few locations. Areas of greatest concern are along main travel corridors and in the Pine Nut, Bodie, and Mount Grant PMUs.

Bromus tectorum out-competes beneficial understory plant species and can dramatically alter fire ecology (See *Wildfire* discussion above). In the Bi-State area, essential sage-grouse habitat is often highly concentrated and a fire event would have significant adverse effects to sage-grouse populations. Land managers have had little success preventing *B. tectorum* invasion in the West. Occurrence of *B. tectorum* in the Bi-State area is apparent at elevations above that thought to be relatively immune based on the grass's ecology. This suggests that few locations in the Bi-State area will be safe from *B. tectorum* invasion in the future. Climate change may strongly influence the outcome of these interactions; the available data suggest that future conditions will be most influenced by precipitation (Bradley 2008, p. 9) (Also see *Climate Change* discussion below).

Pinyon–juniper encroachment into sagebrush habitat is a threat occurring in the Bi-State area (USFS 1966, p. 22). Pinyon–juniper encroachment is occurring to some degree in all PMUs, with the greatest loss and fragmentation of important sagebrush habitat in the Pine Nut, Desert Creek–Fales, Mount Grant, and Bodie PMUs (Bi-State Plan 2004, pp. 20, 39, 96, 133, 137, 167). No data exist for the Bi-State area that quantify the amount of sagebrush habitat lost to encroachment, or that clearly demonstrate pinyon–juniper encroachment has caused greater sage-grouse populations to decline. However, land managers consider it a significant threat impacting habitat quality, quantity and connectivity and increasing the risk of avian predation to sage-grouse populations (Bi-State Plan 2004, pp. 20, 39, 96) and several previously occupied locations are thought to have been abandoned due to encroachment (Bi-State Plan 2004, pp. 20, 133). Management treatment of pinyon–juniper is feasible but is often constrained by competing resource values and cost. Several thinning projects have been completed in the Bi-State area, accounting for approximately 1,618 ha (4,000 ac) of woodland removed.

Summary: Invasive Species, Noxious Weeds, Pinyon-Juniper Encroachment

While the current occurrence of *Bromus tectorum* in the Bi-State area is relatively low, it is likely the species will continue to expand and adversely impact sagebrush habitats and the greater sage-grouse by out-competing beneficial understory plant species and altering the fire ecology of the area. Alteration of the fire ecology of the Bi-State area is of greatest concern (see *Fire* discussion above). Land managers have had little success preventing *B. tectorum* invasion in the West and elevational barriers to invasion are not apparent in the Bi-State area. While climate change may strongly influence the outcome of these interactions, the available data suggest that future conditions will be most influenced by precipitation (Bradley 2008, p. 9). *Bromus tectorum* is a serious threat to the sagebrush shrub community and will be detrimental to greater sage-grouse in the Bi-State area. Encroachment of sagebrush habitats by woodlands is occurring throughout the Bi-State area and continued isolation and reduction of suitable habitats will influence both short- and long-term persistence of sage-grouse.

Climate Change

Global climate change is expected to affect the Bi-State area (Lenihan *et al.* 2003, p. 1674; Diffenbaugh *et al.* 2008, p. 3; Lenihan *et al.* 2008, p. S223). Impacts are not well defined and precise predictions are problematic due to the coarse nature of the climate models and relatively small geographic extent of the area. In general, model predictions tend to agree on an increasing temperature regime (Cayan *et al.* 2008, pp. S38–S40). Model predictions for the Bi-State area, using the mid-range ensemble emissions scenario, show an overall increase in annual temperatures, with some areas projected to experience mean annual temperature increases of 1 to 3 degrees Fahrenheit over the next 50 years (TNC Climate Wizard, 2009). Of greater uncertainty is the influence of climate change on local precipitation (Diffenbaugh *et al.* 2005, p. 15776; Cayan *et al.* 2008, p. S28). This variable is of major importance to greater sage-grouse, as timing and quantity of precipitation greatly influences plant community composition and extent, specifically forb production, which in turn affects nest and chick survival. Across the west, models predict a general increase in precipitation (Neilson *et al.* 2005, p. 150), although scaled-down predictions for the Bi-State area show an overall decrease in annual precipitation ranging from under 1 inch up to 3 inches over the next 50 years (TNC Climate Wizard 2009).

A warming trend in the mountains of western North America is expected to decrease snow pack, accelerate spring runoff, and reduce summer stream flows (Intergovernmental Panel on Climate Change (IPCC) 2007, p. 11). Specifically in the Sierra Nevada, March temperatures have warmed over the last 50 years resulting in more rain than snow precipitation, which translates into earlier snowmelt. This trend is likely to continue and accelerate into the future (Kapnick and Hall 2009, p. 11). This change in the type of precipitation and the timing of snow melt will influence reproductive success by altering the availability of understory vegetation and meadow habitats. Increased summer temperature is also expected to increase the frequency and intensity of wildfires. Westerling *et al.* (2009, pp. 10-11) modeled potential wildfire occurrences as a function of land surface characteristics in California. Their model predicts an overall increase in the number of wildfires and acreage burned by 2085 (Westerling *et al.* 2009, pp. 17-18). Increases in the number of sites susceptible to invasive annual grass and increases in WNv outbreaks are reasonably anticipated (IPCC 2007, p. 13; Lenihan *et al.* 2008, p. S227). Reduction in summer precipitation is expected to produce the most suitable condition for *B. tectorum*. Recent warming is linked, in terrestrial ecosystems, to poleward and upward shifts in plant and animal ranges (IPCC 2007, p. 2).

While it is reasonable to assume the Bi-State area will experience vegetation changes, we do not know how climate change will ultimately effect this greater sage-grouse population. It is unlikely that the current extent of shrub habitat will remain unchanged, whether the shift is toward a grass or woodland dominated system is unknown. Either result will negatively affect greater sage-grouse in the area. Additionally, it is also reasonable to assume that changes in atmospheric carbon dioxide levels, temperature, precipitation, and timing of snowmelt, will act synergistically with other threats such as wildfire and

invasive species to produce yet unknown but likely negative effects to greater sage-grouse habitat and populations in the Bi-State area.

Summary of Factor A

Destruction and modification of greater sage-grouse habitat is occurring and will continue in the Bi-State area due to urbanization, infrastructure (e.g., fences, powerlines, and roads), mining, renewable energy development, grazing, wildfire, and invasive plant species. At the individual PMU level the impact and timing of these threats vary. The Pine-Nut PMU has the lowest number of individuals of all Bi-State area (approximately 89 to 107 in 2009) PMUs and is threatened by urbanization, grazing management, wildfire, invasive species, and energy development. The threats to habitat in this PMU are likely to continue in the future which may result in continued declines in the populations over the short term.

The Desert-Creek Fales PMU contains the greatest number of sage-grouse of all Bi-State PMUs in Nevada (approximately 512 to 575 in 2009). The most significant threats in this PMU are wildfire, invasive species (specifically conifer encroachment), urbanization, and fragmentation. Private lands purchase in California and pinyon-juniper forest removal in Nevada reduced some of the threats at two important locations within this PMU. However, a recent proposal for a land parcel subdivision in proximity to Burcham Flat, California, threatens nesting habitat and one of the two remaining leks in the area. The imminence of these threats varies, however, with urbanization and fragmentation being the most imminent threats to habitat in this PMU.

The Mount Grant PMU has an estimated population of 376 to 427 individuals based on 2009 surveys. Threats in this PMU include renewable energy development and mining associated infrastructure. Additional threats include infrastructure (fences, powerlines, and roads), conifer encroachment, fragmentation, and impacts to mesic habitat on private land from grazing and water table alterations. These threats currently fragment, and may in the future continue to fragment habitat in this PMU and reduce or eliminate connectivity to populations in the Bodie Hills PMU to the west.

The Bodie and South Mono PMUs are the core of greater sage-grouse populations in the Bi-State area, and have estimated populations of 829 to 927 and 906 to 1,012 individuals based on 2009 surveys, respectively. These two PMUs comprise approximately 65 percent of the total population in the Bi-State area. Future loss or conversion of limited brood rearing habitat on private lands in the Bodie PMU is a significant threat to the population. The threat of future wildfire and subsequent habitat loss of conversion to annual grassland is of great concern. Threats from existing and future infrastructure, grazing, mineral extraction, and conifer encroachment are also present but believed to have a relatively lower impact. The most significant threat in the South Mono PMU involves impacts associated with human activity in the forms of urbanization and recreation. Other threats in this PMU include existing and future infrastructure, mining activities, and wildfire, but pose a relatively lower risk to habitat and the DPS.

Information on threats in White Mountains PMU is limited. The area is remote and difficult to access and most data are in the form of random observations. Threats to the habitat in this PMU are low due to the remote location. Activities such as grazing, recreation, and invasive species may be influencing the population but this is speculation. Potential future actions in the form of transmission line, road, and mineral developments are threats that could lead to the loss of the remote but contiguous nature of the habitat.

Predicting the impact of global climate change on sage-grouse populations is challenging due to the relatively small spatial extent of the Bi-State area. It is likely that vegetation communities will not remain static and the amount of sagebrush shrub habitat will decrease. Further, increased variation in drought cycles due to climate change will likely place additional stress on sage-grouse habitat and populations. While greater sage-grouse evolved with drought, drought has been correlated with population declines and shown to be a limiting factor to population growth in areas where habitats have been compromised.

Taken cumulatively, the habitat-based threats in all PMUs will likely act to fragment and isolate populations of the DPS in the Bi-State area. Over the short term (10 years) the persistence of the Pine Nut PMU is not likely. Populations occurring in the Desert Creek–Fales and Mount Grant PMUs are under significant pressure and continued threats to habitat will likely increase likelihood of extirpation. The Bodie and South Mono PMUs are larger and more stable and should continue to persist. While the South Mono PMU appears to be an isolated entity, the Bodie PMU interacts with the Mount Grant and the Desert Creek–Fales PMUs, and the continued loss of habitat in these other locations will likely influence the population dynamics and possibly the persistence of the breeding population occurring in the Bodie PMU. The White Mountain PMU is likely already an isolated population and does not currently or would in the future contribute to the South Mono PMU.

Therefore, based on our review of the best scientific and commercial data available, we conclude threats from the present or threatened destruction, modification, or curtailment of greater sage-grouse habitat or range are significant to the Bi-State DPS of the greater sage-grouse.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.

Hunting

The only known assessment of hunting effects specific to the Bi-State area is an analysis conducted by Gibson (1998) for the Bodie Hills and Long Valley lek complexes. This assessment indicated that populations in the South Mono PMU (Long Valley area) were depressed by hunting from the late 1960's to 2000 but the Bodie Hills population was not. The results of Gibson (1998) influenced the CDFG management of the Long Valley population through the limitation of allocated hunting permits (Gardner 2008, pers. comm.).

Prior to 1983, California had no limit on hunting permits in the area which covers the Bodie Hills portion of the Bodie PMU (North Mono Hunt Area) and the Long Valley portion of the South Mono PMU (South Mono Hunt Area). In 1983, CDFG closed the hunting season (Bi-State Plan 2004, pp. 73–74); however, it was reopened in 1987 when CDFG instituted a permit system that resulted in limiting the number of permits (hundreds) issued annually. In 1998, the number of permits issued was significantly reduced (Bi-State Plan 2004, pp. 74–75; Gardner 2008, pers. comm.).

From 1998 to the present, the number of hunting permits issued by the CDFG has ranged from 10 to 35 per year for the North Mono and South Mono Hunt Areas (Bi-State Plan 2004, p. 173; CDFG 2008). In 2008, 25 single bird harvest permits were issued for the North Mono Hunt Area, and 35 single bird harvest permits were issued for the South Mono Hunt Area (CDFG 2008). Assuming all permits were filled, and comparing these estimated harvest levels to the low spring population estimates for the Bodie and South Mono PMUs for 2008, there was an estimated loss of about 4

percent for each population (25 of 573 and 35 of 838 for Bodie PMU and South Mono PMU, respectively). These harvest levels are within the harvest rate of 10 percent or less recommended by Connelly *et al.* (2000a, p. 976). The CDFG evaluated the effect of their greater sage-grouse hunting season for California as part of an overall assessment of the effects of their resident game bird hunting seasons (CDFG 2002). They concluded that the removal of individual animals from resident game bird populations statewide (including greater sage-grouse) will not significantly reduce those populations and will therefore not have a significant environmental impact on resident game birds (CDFG 2002, p. 7).

Hunting (gun) has been closed in the Nevada portion of the Bi-State area since 1999 (NDOW 2006, p. 2). The falconry season in this area was closed in 2003 (Espinosa 2006b, pers. comm.). The Washoe Tribe has authority over hunting on tribal allotments in the Pine Nut PMU. There are anecdotal reports of harvest by Tribal members but currently the Washoe Tribe Hunting and Fishing Commission does not issue harvest permits for greater sage-grouse nor are historical harvest records available (J. Warpea 2009, pers. comm.).

Neither the CDFG nor NDOW had any information on poaching of greater sage-grouse or the accidental taking of this species by hunters pursuing other upland game birds with open seasons for the Bi-State area. Gibson (2001, p. 4) does mention that a low level of known poaching occurred in Long Valley. Hunting has suppressed some populations in the Bi-State area historically. Harvest has been estimated to be as much as 4 percent of the population in Bodie and South Mono PMUs. While this may be considered to be at levels considered compensatory and within harvest guidelines, in Long Valley it likely continues to impact population growth.

Recreational, Scientific, and Religious Use

The CDFG and NDOW provide public direction to leks and guidelines to minimize viewing disturbance on a case-by-case basis. Overall, lek locations in the Bi-State area are well known and some are frequently visited. Disturbance is possible; however, we have no data to suggest that non-consumptive recreational uses of greater sage-grouse are impacting local populations in the Bi-State area (Gardner 2008, pers. comm.; Espinosa 2008, pers. comm.). We are not aware of any studies of lek viewing or other forms of non-consumptive recreational uses related to greater sage-grouse population trends. We have no information that this type of recreational activity is having a negative impact on local populations or contributing to declining population trends of greater sage-grouse in the Bi-State area.

Regarding possible effects from scientific studies of greater sage-grouse, in the past 5 years, approximately 200 greater sage-grouse have been captured and handled by researchers. Casazza *et al.* (2009, p. 45) indicates that, in 3 years of study of radio-marked greater sage-grouse, the deaths of four birds in the Bi-State area were attributed to researchers.

Summary of Factor B

Overall in the Bi-State area hunting is limited to such a degree that it is not apparently restrictive to overall population growth. However, hunting was shown to limit the population of greater sage-grouse occurring within the South Mono PMU historically and even at its current reduced level still likely suppresses this population. While hunting in the Bodie PMU appears to be compensatory, given this PMU's connection with the neighboring and non-hunted Mount Grant PMU and the current declines apparent in the Mount Grant population, additional evaluation of this hunting across jurisdictional boundaries is warranted. We have no information indicating poaching, non-consumptive uses, or scientific use significantly impact Bi-State greater sage-grouse populations, either separately of collectively. Therefore, based on our review of the best scientific and commercial data available we find that overutilization for commercial, recreational, scientific, or educational purposes is not a significant threat to the Bi-State DPS of the greater sage-grouse.

Factor C: Disease and Predation.

Disease

West Nile virus (WNv) is the only identified disease that warrants concern for greater sage-grouse in the Bi-State area. Small populations, such as those in the Bi-State area, are at higher risk of extirpation due to their low numbers and the additive mortality WNv causes (see *Disease* discussion under Factor C in the GSG finding, above). Larger populations may be better able ''absorb'' losses due to WNv simply due to their size (Walker and Naugle in press, p. 25). The documented loss of four greater sage-grouse to WNv in the Bodie (n=3) and Desert Creek–Fales (n=1) PMUs (Casazza *et al.* 2009, p. 45) has heightened our concern about the impact of this disease in the Bi-State area, especially given the small population sizes. These mortalities represented four percent of the total greater sage-grouse mortalities observed, but additional reported mortality due to predation could have been due in part to disease-weakened individuals. Mortality caused by disease acts in a density independent, or additive, manner. While four percent may not appear substantial, the fact that it can act independently of habitat and has the potential to suppress a population below carrying capacity makes disease of a greater concern.

Annual and spatial variations in temperature and precipitation influence WNv outbreaks. Much of the Bi-State area occurs at relatively high elevations with short summers, and these conditions likely limit the extent of mosquito and WNv occurrence, or at least may limit outbreaks to the years with above-average temperatures. The Bi-State area represents the highest known elevation at which greater sage-grouse have been infected with WNv, about 2,300 m (7,545 ft; Walker and Naugle *in press*, p. 12). Casazza *et al.* (2009) captured birds in the White Mountains, South Mono, Bodie, and California portion of the Desert Creek–Fales PMUs, and mortality rates at these locations may not be representative of the remainder of the Bi-State area, which occurs at lower elevations on average. The WNv was first documented in the State of California in 2003 (Reisen *et al.* 2004, p. 1369), thus, the impact of the virus during the 2003–2005 study years may be an underrepresentation of current conditions. From 2004 to 2008, the U.S. Geological Survey reported 79 cases of WNv in birds (species undefined) from Mono, Douglas, Lyon, and Mineral Counties (*http://diseasemaps.usgs.gov*), accessed February 27, 2009).

The extent that WNv influences greater sage-grouse population dynamics in the Bi-State area is uncertain, and barring a severe outbreak, natural variations in survival and reproductive rates that drive population growth may be masking the true impact of the disease. However, the dramatic fluctuations in recent lek counts in the Desert Creek–Fales and Mount Grant PMUs may indicate past outbreaks. Based on our current knowledge of the virus, the relatively high elevations and cold temperatures common in much of the Bi-State area likely reduce the chance of a population-wide outbreak. However, there may be localized areas of significant outbreaks that could

influence individual populations. West Nile virus is a relatively new source of mortality for greater sage-grouse and to date has been limited in its impact in the Bi-State area. Although predicting precisely when and where further outbreaks will occur is not possible, the best scientific data available support a conclusion that outbreaks are very likely to continue to occur. However, the loss of individual populations from WNv outbreaks, which is particularly a risk for smaller populations, may influence the persistence of the Bi-State DPS through the loss of redundancy to the overall population and the associated challenges of recolonizing extirpated sites through natural emigration.

Predation

Range-wide, annual mortality of breeding-age greater sage-grouse varies from 55 to 75 percent for females and 38 to 60 percent for males, with the majority of mortality attributable to predation (Schroeder and Baydack 2001, p. 25). Although not delineated by sex, the best data available for the Bi-State population reports apparent annual adult mortality due to predation of between 58 and 64 percent (Casazza *et al*. 2009, p. 45). This loss of radio-collared greater sage-grouse in the Bi-State area to predators is well within normal levels across the range of the species. However, estimates of adult survival vary substantially across the Bi-State area and in several locations adult survival in the Bi-State area is below that considered sustainable by some researchers (Farinha *et al*. 2008, unpublished data; Sedinger *et al*. unpublished data., p. 12). Where good-quality habitat is not a limiting factor, research suggests it is unlikely that predation influences the persistence of the species (see *Predation* under the Greater sage-grouse finding above). Thus, we consider the low estimates of adult survival in the northern half of the Bi-State area to be a manifestation of habitat degradation or other anthropogenic factors that can alter natural predator–prey dynamics such as introduced nonnative predators or human-subsidized native predators.

Nest success across the Bi-State area is within the normal range, with some locations even higher than previously documented (Kolada 2007, p. 52). The lowest estimates occur in Long Valley (21 percent; Kolada 2007, p. 66). The low estimates in Long Valley are of concern as this population represents the stronghold for the species in the Bi-State area and is also the population most likely exposed to the greatest predation (Coates 2008, pers. comm.). Although significantly more birds were present in the past, the Long Valley population appears stable. The negative impact from reduced nesting success is presumably being offset by other demographic statistics such as high chick or adult survival.

Summary of Factor C

We have a poor understanding of the effects of disease on Bi-State greater sage-grouse populations, and we are concerned about the potential threat, especially in light of recent documented presence of WNv and the potential impacts this disease can have on population growth. WNv is a substantial mortality factor for greater sage-grouse populations when outbreaks occur. We will continue to monitor future infections and observe population response. Predation is the primary cause of mortality in the Bi-State area (Casazza *et al*. 2009, p. 45), as it is for greater sage-grouse throughout its range (see discussion of predation related to the greater sage-grouse rangewide, above). In several locations in the northern Bi-State area (Bodie Hills, Desert Creek, Fales), adult survival is below what some researchers consider to be sustainable (Farinha *et al*. 2008, unpublished data; Sedinger *et al*. unpublished data., p. 12). Low (21 percent) nest success in at least one area (Long Valley) may be associated with higher local densities of predators (Coates 2008, pers. comm.). Studies suggest predator influence is more pronounced in areas of poor habitat conditions. The ultimate cause of reduced population growth and survival appears to stem from impacts from degraded habitat quality. The impacts from roads, powerlines, and other anthropogenic features (landfills, airports, and urbanization) degrade habitat quality and increase the densities of native and nonnative predators which results in negative effects to greater sage-grouse population dynamics. Therefore, after reviewing the best scientific and commercial data available we have determined that disease and predation are threats to the Bi-State DPS, although the impact of these threats is relatively low and localized at this time compared to other threats.

Factor D: Inadequacy of Existing Regulatory Mechanisms.

As discussed in Factor D of the GSG finding above, existing regulatory mechanisms that could provide some protection for greater sage-grouse include: (1) local land use laws, processes, and ordinances; (2) State laws and regulations; and (3) Federal laws and regulations. Actions adopted by local groups, states, or federal entities that are discretionary, including conservation strategies and guidance, are not regulatory mechanisms.

Local Laws and Regulations

Approximately 8 percent of the land in the Bi-State area is privately owned (Bi-State Plan 2004). We are not aware of any existing county or city ordinances that provide protection specifically for the greater sage-grouse or their habitats on private lands.

State Laws and Regulations

In the Bi-State area, greater sage-grouse are managed by two state wildlife agencies (NDOW and CDFG) as resident native game birds. The game bird classification allows the direct human taking of greater sage-grouse during hunting seasons authorized and conducted under state laws and regulations. Currently, harvest of greater sage-grouse is authorized in two hunt units in California, covering approximately the Long Valley and Bodie Hills populations (CDFG 2008). Greater sage-grouse hunting is prohibited in the Nevada portion of the Bi-State area, where the season has been closed since 1999 (Greater Sage-Grouse Conservation Plan for Nevada and Eastern California 2004, pp. 59-61).

Each State bases its hunting regulations on local population information and peer-reviewed scientific literature regarding the impacts of hunting on the greater sage-grouse. Hunting seasons or closures are reviewed annually, and States implement adaptive management based on harvest and population data (Espinosa 2008, pers. com.; Gardner 2008, pers. com.). Based on the best data available, we can not determine whether or how hunting mortality, is affecting the populations. Therefore, we do not have information to indicate how regulated hunting is affecting the DPS.

State agencies directly manage approximately 1 percent of the total landscape dominated by sagebrush in the Bi-State area, and various State laws and regulations identify the need to conserve wildlife habitat (Bi-State Plan 2004). Laws and regulations in both California and Nevada allow for acquisition of funding to acquire and conserve wildlife habitats, including land purchases and entering into easements with landowners. California recently purchased approximately 470 ha (1,160 ac) in the Desert Creek–Fales PMU largely for the conservation of greater sage-grouse (Taylor 2008, pers. com.). However, any acquisitions authorized are discretionary on the part of the agencies and cannot be

considered an adequate mechanism that alleviates threats to the DPS or its habitat.

The Bi-State Plan (2004) represents more than 2 years of collaborative analysis by numerous local biologists, land managers, and land users who share a common concern for the greater sage-grouse occurring in western Nevada and eastern California. The intent of the plan was to identify factors that negatively affect greater sage-grouse populations in the Bi-State area as well as conservation measures likely to ameliorate these threats and maintain these populations. These efforts are in addition to current research and monitoring efforts conducted by the States. These voluntary recommended conservation measures are in various stages of development and depend on the cooperation and participation of interested parties and agencies. The Bi-State Plan does not include any prohibitions against actions that harm greater sage-grouse or their habitat. Since development of the Bi-State Plan, the NDOW has committed approximately $250,000 toward conservation efforts, some of which have been implemented while others are pending. Other support has come from various federal, state, and local agencies. For example, a partnership between the NDOW and the USFS resulted in a recently completed pinyon–juniper removal project in the Sweetwater Range in the Desert Creek–Fales PMU encompassing about 1,300 ha (3,200 ac) of important greater sage-grouse habitat (NDOW 2008, p. 24). Additional efforts are also being developed to target restoration of important nesting, brood rearing, and wintering habitat components across the Bi-State area. However, the Bi-State Plan is not a regulation and its implementation depends on voluntary efforts. Thus the Bi-State Plan can not be considered to be an adequate regulatory mechanism.

The California Environmental Quality Act (CEQA) (Public Resources Code sections 21000–21177), requires full disclosure of the potential environmental impacts of projects proposed by state and local agencies. The public agency with primary authority or jurisdiction over the project is responsible for conducting an environmental review of the project, and consulting with the other agencies concerned with the resources affected by the project. Section 15065 of the CEQA guidelines requires a finding of significance if a project has the potential to ''reduce the number or restrict the range of a rare or endangered plant or animal.'' Species that are eligible for listing as rare, threatened, or endangered but are not so listed are given the same protection as those species that are officially listed with the State. However, once significant effects are identified, the lead agency has the option to mitigate the effects through changes in the project, or decide that overriding considerations, such as social or economic considerations, make mitigation infeasible (CEQA section 21002). In the latter case, projects may be approved that cause significant environmental damage, such as destruction of endangered species, and their habitat. Protection of listed species through CEQA is dependent upon the discretion of the agency involved. Therefore, CEQA may not act as a regulatory mechanism for the protection of the DPS.

Federal Laws and Regulations

Federally owned and managed land make up the majority of the landscape within the DPS's range. For a comprehensive discussion and analysis of federal laws and regulations please see this section under Factor D of the GSG finding.

Approximately 50 percent of the land base in the Bi-State area occurs on lands managed by the BLM. As stated in the GSG finding, FLPMA is the primary federal law governing most land uses on BLM-administered lands. Under FLPMA, the BLM has authority over livestock grazing, recreation, OHV travel and human disturbance, infrastructure development, fire management, and either in combination with or under the MLA and other mineral and mining laws, energy development and mining on its lands. In Nevada and California, the BLM manages for many of these activities within their jurisdiction. In Nevada and California, the BLM has designated the greater sage-grouse a sensitive species. BLM's management of lands in the Bi-State area is conducted consistent with its management of its lands across the greater sage-grouse range. Therefore, we refer the reader to the GSG finding above for a detailed discussion and analysis BLM's management of sage-grouse habitat on its lands.

The USFS manages approximately 35 percent of the land base in the Bi-State area. As stated in the GSG finding, management of activities on lands under USFS jurisdiction is guided principally by NFMA through associated LRMPs for each forest unit. Under NFMA and other federal laws, the USFS has authority to regulate recreation, OHV travel and other human disturbance, livestock grazing, fire management, energy development, and mining on lands within its jurisdiction. Please see the GSG finding for general information and analysis. All of the LRMPs that currently guide the management of sage-grouse habitats on USFS lands were developed using the 1982 implementing regulations for land and resource management planning (1982 Rule, 36 CFR 219), including two existing USFS LRMPs (USFS 1986, 1988) within greater sage-grouse habitat in the Bi-State area.

The greater sage-grouse is designated as a USFS Sensitive Species in the Intermountain Region (R4) and Pacific Southwest Region (R5), which include the Humboldt–Toiyabe National Forest's Bridgeport Ranger District and the Inyo National Forest in the Bi-State area. The specifics of how sensitive species status has conferred protection to sage-grouse on USFS lands varies significantly across the range, and is largely dependent on LRMPs and site-specific project analysis and implementation. The Inyo National Forest identifies sage-grouse as a Management Indicator Species. This identification requires the USFS to establish objectives for the maintenance and improvement of habitat for the species during all planning processes, to the degree consistent with overall multiple use objectives (1982 rule, 36 CFR 219.19(a)).

As part of the USFS Travel Management planning effort, both the Humboldt-Toiyabe National Forest and the Inyo National Forest are revising road designations in their jurisdictions. The Humboldt-Toiyabe National Forest released its Draft Environmental Impact Statement in July, 2009. The Inyo National Forest completed and released its Final Environmental Impact Statement and Record of Decision in August 2009 for Motorized Travel Management. The ROD calls for the permanent prohibition on cross country travel off designated authorized roads. However, since this prohibition is not specific to sage-grouse habitat and we cannot assess how this will be enforced, we cannot consider the policy to be a regulatory mechanism that can protect the DPS.

Additional federally managed lands in the Bi-State area include the DOD Hawthorne Army Depot, which represents less than 1 percent of the total land base. However, these lands provide relatively high quality habitat (Nachlinger 2003, p. 38) and likely provide some of the best greater sage-grouse habitat remaining in the Mount Grant PMU because of the exclusion of livestock and the public (Bi-State Plan 2004, p. 149). There are no National Parks or National Wildlife Refuges in any of the PMUs in the Bi-State area,

and we are unaware of any private lands in the area that are enrolled in the United States Department of Agriculture Conservation Reserve Program.

Summary of Factor D

As described above, habitat destruction and modification in the Bi-State area is a threat to the DPS. Federal agencies' abilities to adequately address several issues such as wildfire, invasive species, and disease across the Bi-State area are limited. For other stressors such as grazing, the regulatory mechanisms in place could be adequate to protect sage-grouse habitats; however, the application of these mechanisms varies. In some locations rangelands are not meeting habitat standards necessary for sage-grouse persistence, however, overall population estimates, while variable from year-to-year, show no discernable trend attributable to grazing.

The statutes, regulations, and policies guiding renewable energy development and associated infrastructure development, and mineral extraction for the greater sage-grouse range-wide generally are implemented similarly in the Bi-State area as they are across the range of the greater sage-grouse, and it is our conclusion that this indicates that current measures do not ameliorate associated impacts to the DPS.

The existing state and federal regulatory mechanisms to protect greater sage-grouse in the Bi-State area afford sufficient discretion to decision makers as to render them inadequate to ameliorate threats to the Bi-State DPS. We do not suggest that all resource decisions impacting sage-grouse have failed to adequately address sage-grouse needs and in fact commend the individuals and agencies working in the Bi-State area. However, the flexibility built into the regulatory process greatly reduces the adequacy of these mechanisms. Because of this, the available regulatory mechanisms are not sufficiently reliable to provide for conservation of the species in light of the alternative resource demands. Therefore, after a review of the best scientific and commercial data available, we find that the existing regulatory mechanisms are inadequate to ameliorate the threats to the Bi-State DPS of the greater sage-grouse.

Factor E: Other Natural or Manmade Factors Affecting the Species' Continued Existence.

Recreational Activities

A variety of recreational activities are pursued across the Bi-State area, including traditional activities such as fishing, hiking, horseback riding, and camping as well as more recently popularized activities, such as off-road-vehicle travel and mountain biking. As discussed under *Recreational Activities* under Factor E in the GSG finding above, these activities can degrade habitat and affect sage-grouse reproduction and survival by causing disturbance in these areas.

The Bi-State Plan (2004) discusses the risk associated with off-road vehicles in the Pine Nut and the Mount Grant PMUs (Bi-State Plan 2004, pp. 27, 137–138). Additionally, for the Bodie and South Mono PMUs, the Bi-State Plan (2004, pp. 91–92, 170–171) discusses off-road vehicles in the context of all types of recreational activities (motorized and non-motorized). We are not aware of any scientific reports that document direct mortality of greater sage-grouse through collision with off-road vehicles (70 FR 2278), although mortality from collision with vehicles on U.S. 395 near Mammoth Lakes is known (Wiechmann 2008, p. 3). Off-road vehicle use has indirect impacts to greater sage-grouse habitat; it is known to reduce or eliminate sagebrush canopy cover through repeated trips in an area, degrade meadow habitat, increase sediment production, and decrease soil infiltration rates through compaction (70 FR 2278).

Potential disturbance caused by nonmotorized forms of recreation (fishing, camping, hiking, big game hunting, dog training) are most prevalent in the South Mono and Bodie PMUs. These PMUs are also exposed to tourism-associated activity centered around Mono Lake and the towns of Mammoth Lakes and Bodie. The exact amount of recreational activity or user days occurring in the area is not known, however, the number of people in the area is increasing annually (Nelson 2008, pers. comm.; Taylor 2008, pers. comm.). Additionally, with the recent reestablishment of commercial air service to the Mammoth Yosemite Airport during the winter, greater sage-grouse in the South Mono PMU will be exposed to more flights during leking and the early nesting season than previously experienced. The early nesting season (in addition to the already busy summer months) will present the most significant new overlap between birds and human activity in the area. Leu *et al.* (2008, p. 1133) reported that slight increases in human densities in ecosystems with low biological productivity (such as sagebrush) may have a disproportional negative impact on these ecosystems due to reduced resiliency to anthropogenic disturbances. The greatest concern is the relatively concentrated recreational activity occurring in the South Mono PMU, which overlaps with the single most abundant greater sage-grouse population in the Bi-State area.

We are unaware of instances where off-road vehicle (including snowmobile) activity precluded greater sage-grouse use, or affected survival in the Bi-State area. There are areas where concerns may arise though, especially in brood rearing and wintering habitats, which are extremely limited in the Bi-State area. For example, during heavy snow years, essentially the entire population of birds in Long Valley has congregated in a very small area (Gardner 2008, pers. comm.). Off-road vehicle or snowmobile use in occupied winter areas could displace them to less optimal habitats (Bi-State Plan 2004, p. 91). Given the likelihood of a continuing influx of people into Mono County, especially in proximity to Long Valley, with access to recreational opportunities on public lands, we anticipate effects from recreational activity will increase.

Life History Traits Affecting Population Viability

Greater sage-grouse have comparatively slower potential population growth rates than other species of grouse and display a high degree of site fidelity to seasonal habitats (see this section under Factor E in the GSG finding above for further discussion and analysis). While these natural history characteristics would not limit greater sage-grouse populations across large geographic scales under historical conditions of extensive habitat, they may contribute to local declines where humans alter habitats, or when natural mortality rates are high in small, isolated populations such as in the case of the Bi-State DPS.

Isolated populations are typically at greater risk of extinction due to genetic and demographic concerns such as inbreeding depression, loss of genetic diversity, and Allee effect (the difficulty of individuals finding one another), particularly where populations are small (Lande 1988, pp. 1456–1457; Stephens *et al.* 1999, p. 186; Frankham *et al.* 2002, pp. 312–317). The best estimates for the Bi-State DPS of the greater sage-grouse place the spring breeding population between 2,000 and 5,000 individuals annually (Gardner 2008, pers. comm.; Espinosa 2008, pers. comm.). Based on radio-telemetry and genetic data, the local populations of greater sage-grouse in the Bi-State area appear to be isolated to varying degrees from one another (Farinha 2008, pers. comm.). Birds occurring in the White Mountains PMU as well as those occurring in the Long Valley and Parker

Meadows area of the South Mono PMU are isolated from the remainder of the Bi-State populations, and apparently from one another (Casazza *et al.* 2009, pp. 34, 41; Oyler–McCance 2009, pers. comm.). The isolation of populations occurring to the north of Mono Lake is less clear. Birds occurring in the Bodie and Mount Grant PMUs mix during parts of the year, as do birds occurring in the California and Nevada portions of the Desert Creek–Fales PMUs (Casazza *et al.* 2009, pp. 13, 21). Within the Mount Grant PMU, populations occurring on and around Mount Grant do not interact with populations in the remainder of the PMU. However, movement of birds between Mount Grant and Desert Creek–Fales or Bodie and Desert Creek–Fales PMUs appears less consistent. The interaction among birds occurring in the Pine Nut PMU with PMUs to the south is unknown. Based on about 150 marked individuals, no dispersal events were documented among any of the PMUs, suggesting that even though some populations were mixing during certain times of the year, there was no documented integration among breeding individuals (Farinha 2008, pers. comm.). While adults are unlikely to switch breeding populations, it is likely that genetic material is transferred among these northern populations through the natural movements of chicks or young of the year, as long as there are established populations available to emigrate into.

We have concern regarding viability of populations within PMUs in the Bi-State area due to their small size (Table 12) and isolation from one another. Although there is disagreement among scientists and considerable uncertainty as to the population size adequate for long-term persistence of wildlife populations, there is agreement that population viability is more likely to be ensured viability if population sizes are in the thousands of individuals rather than hundreds (Allendorf and Ryman 2002, p. 76; Aldridge and Brigham 2003, p. 30; Reed 2005, p. 565; Traill *et al.*, 2009 entire). For example, Traill *et al.* (2009, pp. 30, 32-33) concluded that, in general, both evolutionary and demographic constraints on wildlife populations require sizes to be at least 5,000 adult individuals.

The Bi-State population of greater sage-grouse is small and both geographically and genetically isolated from the remainder of the greater sage-grouse distribution, which increases risk of genetic, demographic, stochastic events. To date, however, available genetic data suggest genetic diversity in the Bi-State area is as high as or higher than most other populations of greater sage-grouse occurring in the West (Oyler–McCance and Quinn in press, p. 18). Thus, we currently do not have clear indications that genetic factors such as inbreeding depression, hybridization, or loss of genetic diversity place this DPS at risk. However, recent genetic analysis shows that greater sage-grouse occupying the White Mountains display a unique allelic frequency in comparison to other populations in the Bi-State area suggesting greater isolation (Oyler–McCance 2009, pers. comm.). Additionally, recent field studies in the Parker Meadows area (a single isolated lek system located in the South Mono PMU) documented a disproportionally high degree of nest failures due to nonviable eggs (Gardner 2009, pers. comm.).

In addition to the potential negative effects to small populations due to genetic considerations, small populations such as those found in the Bi-State area are at greater risk than larger populations from stochastic events, such as environmental catastrophes or random fluctuations in birth and death rates, as well disease epidemics, predation, fluctuations in habitat available, and various other factors (see Traill *et al.*, p. 29.). Interactions between climate change, drought, wildfire, WNv, and the limited potential to recover from population downturns or extirpations place significant impediments to the persistence of the Bi-State DPS of the greater sage-grouse.

Summary of Factor E

Our analysis shows certain recreational activities have the potential to directly and indirectly affect sage-grouse and their habitats. However, based on the information available, it does not appear that current disturbances are occurring at such a scale that would adversely affect sage-grouse populations in the Bi-State area. While this determination is highly constrained by lack of data, populations in the South Mono PMU, which are arguably exposed to the greatest degree of recreational activity, appear relatively stable at present. When issues such as recreation and changes in habitat are considered in conjunction with other threats, it is likely that populations in the northern half of the Bi-State area will be extirpated. Reintroduction efforts involving greater sage-grouse have had very limited success elsewhere, and natural recolonization of these areas will be slow or impossible due to their isolation and the limited number of birds in surrounding PMUs, as well as the constraints inferred by the species' life history characteristics. Therefore, based on our evaluation of the best scientific and commercial data available, we find threats from other natural or manmade factors are significant to the Bi-State DPS of the greater sage-grouse.

Finding

We have carefully assessed the best scientific and commercial data available regarding the past, present, and future threats to the Bi-State DPS of the greater sage-grouse. We have reviewed the petition, information available in our files, and other published and unpublished information, and consulted with recognized greater sage-grouse and sagebrush experts.

Threats identified under Factors A, C, D, and E are a threat to the Bi-State DPS of the greater sage-grouse. These threats are exacerbated by the small population sizes, isolated nature, and limited availability of important seasonal habitats for many Bi-State area populations. The major threat is current and future destruction, modification, or curtailment of habitats in the Bi-State area due to urbanization, infrastructure, mining, energy development, grazing, invasive and exotic species, pinyon–juniper encroachment, recreation, wildfire, and the likely effects of climate change. Individually, any one of these threats appears unlikely to severely affect persistence across the entire Bi-State DPS of the greater sage-grouse. Cumulatively, however, these threats interact in such a way as to fragment and isolate, and will likely contribute to the loss of populations in the Pine Nut and Desert Creek-Fales PMUs and will result in a significant range contraction for the Bi-State DPS. The Bodie and South Mono PMUs currently comprise approximately 65 percent of the entire DPS and will likely become smaller but persist barring catastrophic events. In light of on-going threats, the northern extent of the Bi-State area including the Pine Nut, Desert Creek–Fales, and Mount Grant PMUs are and will be most at risk. We anticipate loss of populations and contraction of others which would leave them susceptible to extirpation from stochastic events, such as wildfire, drought, and disease.

While sport hunting is currently limited and within harvest guidelines, if hunting continues it may add to the overall decline of adult populations in the Bodie and South Mono PMUs. Overall in the Bi-State area hunting is limited to such a degree that it is not apparently restrictive to overall population growth. We have no information indicating poaching, non-consumptive uses, or scientific use

significantly impact Bi-State greater sage-grouse populations. Therefore, we find that overutilization for commercial, recreational, scientific, or educational purposes is not a significant threat to the Bi-State area DPS.

West Nile virus is a threat to the greater sage-grouse, and its occurrence and impacts are likely underestimated due to lack of monitoring. While the impact of this disease is currently limited by ambient temperatures that do not allow consistent vector and virus maturation, predicted temperature increases associated with climate change may result in this threat becoming more consistently prevalent. Predation facilitated by habitat fragmentation due to infrastructure (fences, powerlines and roads) and other human activities may be altering natural population dynamics in localized areas such as Long Valley. We find that disease and predation are threats to the Bi-State area DPS, although the impact of these threats is relatively low and localized at this time compared to other threats.

An examination of regulatory mechanisms for both the Bi-State DPS of the greater sage-grouse and sagebrush habitats revealed that while some mechanisms exist, it appears that they are being implemented in a manner that is not consistent with our current understanding of the species' life history requirements, reaction to disturbances, and currently understood conservation needs. Therefore, we find the existing regulatory mechanisms are ineffective at ameliorating habitat-based threats. Furthermore, certain threats (disease, drought, fire) may not be able to be adequately addressed by existing regulatory mechanisms.

Our analysis under Factor E indicates the current level of recreational activities do not appear to be adversely affecting sage-grouse populations in the Bi-State area. Populations in the South Mono PMU, which are arguably exposed to the greatest degree of recreational activity, appear relatively stable at present.

The relatively low number of local populations of greater sage-grouse, their small size, and relative isolation is problematic. The Bi-State area is composed of approximately 35 active leks representing 4 to 8 individual populations. Research has shown fitness and population size are strongly correlated and smaller populations are more subject to environmental and demographic stochasticity. When coupled with mortality stressors related to human activity and significant fluctuations in annual population size, long-term persistence of small populations is always problematic.

Given the species' relatively low rate of growth and strong site fidelity, recovery and repopulation of extirpated areas will be slow and infrequent. Translocation of this species is difficult and to date has not been successful, and given the limited number of source individuals, translocation efforts, if needed, are unlikely.

Within 30 years it is likely that greater sage-grouse in the Bi-State area will only persist in one or two populations located in the South Mono PMU (Long Valley) and the Bodie Hills PMU. These populations will likely be isolated from one another and due to decreased population numbers, each will be at greater risk to stochastic events.

As required by the Act, we have reviewed and taken into account efforts being made to protect the greater sage-grouse in the Bi-State area. Although some local conservation efforts have been implemented and are effective in small areas, they are neither individually nor collectively at a scale that is sufficient to ameliorate threats to the DPS as a whole, or to local populations. Other conservation efforts are being planned but there is substantial uncertainty as to whether, where, and when they will be implemented, and whether they will be effective.

We have carefully assessed the best scientific and commercial information available regarding the present and future threats to the Bi-State DPS of the greater sage-grouse. We have reviewed the petitions, information available in our files, and other published and unpublished information, and consulted with recognized greater sage-grouse and sagebrush experts. We have considered and taken into account efforts being made to protect the species. On the basis of the best scientific and commercial information available, we find that listing of the Bi-State DPS of the greater sage-grouse is warranted across its range. However, listing this DPS is precluded by higher priority listing actions at this time, as discussed in the **Preclusion and Expeditious Progress** section below.

We have reviewed the available information to determine if the existing and foreseeable threats render the Bi-State DPS of the greater sage-grouse at risk of extinction now such that issuing an emergency regulation temporarily listing the species as per section 4(b)(7) of the Act is warranted. We have determined that issuing an emergency regulation temporarily listing the Bi-State DPS is not warranted at this time (see discussion of listing priority for this DPS, below). However, if at any time we determine that issuing an emergency regulation temporarily listing the Bi-State DPS is warranted, we will initiate this action at that time.

Preclusion and Expeditious Progress

Preclusion is a function of the listing priority of a species in relation to the resources that are available and competing demands for those resources. Thus, in any given fiscal year (FY), multiple factors dictate whether it will be possible to undertake work on a proposed listing regulation or whether promulgation of such a proposal is warranted but precluded by higher-priority listing actions.

The resources available for listing actions are determined through the annual Congressional appropriations process. The appropriation for the Listing Program is available to support work involving the following listing actions: proposed and final listing rules; 90–day and 12–month findings on petitions to add species to the Lists of Endangered and Threatened Wildlife and Plants (Lists) or to change the status of a species from threatened to endangered; annual determinations on prior ''warranted but precluded'' petition findings as required under section 4(b)(3)(C)(i) of the Act; critical habitat petition findings; proposed and final rules designating critical habitat; and litigation-related, administrative, and program-management functions (including preparing and allocating budgets, responding to Congressional and public inquiries, and conducting public outreach regarding listing and critical habitat). The work involved in preparing various listing documents can be extensive and may include, but is not limited to: gathering and assessing the best scientific and commercial data available and conducting analyses used as the basis for our decisions; writing and publishing documents; and obtaining, reviewing, and evaluating public comments and peer review comments on proposed rules and incorporating relevant information into final rules. The number of listing actions that we can undertake in a given year also is influenced by the complexity of those listing actions; that is, more complex actions generally are more costly. For example, during the past several years, the cost (excluding publication costs) for preparing a 12–month finding, without a proposed rule, has ranged from approximately $11,000 for one species with a restricted range and involving a relatively uncomplicated analysis, to $305,000 for another species that is wide-ranging and involved a complex analysis.

We cannot spend more than is appropriated for the Listing Program without violating the Anti-Deficiency Act (see 31 U.S.C. § 1341(a)(1)(A)). In addition, in FY 1998 and for each FY since then, Congress has placed a statutory cap on funds which may be expended for the Listing Program, equal to the amount expressly appropriated for that purpose in that fiscal year. This cap was designed to prevent funds appropriated for other functions under the Act (for example, recovery funds for removing species from the Lists), or for other Service programs, from being used for Listing Program actions (see House Report 105-163, 105th Congress, 1st Session, July 1, 1997).

Recognizing that designation of critical habitat for species already listed would consume most of the overall Listing Program appropriation, Congress also put a critical habitat subcap in place in FY 2002, and has retained it each subsequent year to ensure that some funds are available for other work in the Listing Program: ''The critical habitat designation subcap will ensure that some funding is available to address other listing activities'' (House Report No. 107-103, 107th Congress, 1st Session, June 19, 2001). In FY 2002 and each year until FY 2006, the Service has had to use virtually the entire critical habitat subcap to address court-mandated designations of critical habitat. Consequently, none of the critical habitat subcap funds have been available for other listing activities. In FY 2007, we were able to use some of the critical habitat subcap funds to fund proposed listing determinations for high-priority candidate species. In FY 2009, while we were unable to use any of the critical habitat subcap funds to fund proposed listing determinations, we did use some of this money to fund the critical habitat portion of some proposed listing determinations, so that the proposed listing determination and proposed critical habitat designation could be combined into one rule, thereby being more efficient in our work. In FY 2010, we are using some of the critical habitat subcap funds to fund actions with statutory deadlines.

Thus, through the listing cap, the critical habitat subcap, and the amount of funds needed to address court-mandated critical habitat designations, Congress and the courts have, in effect, determined the amount of money available for other listing activities. Therefore, the funds in the listing cap, other than those needed to address court-mandated critical habitat for already-listed species, set the limits on our determinations of preclusion and expeditious progress.

Congress also recognized that the availability of resources was the key element in deciding, when making a 12–month petition finding, whether we would prepare and issue a listing proposal or instead make a ''warranted but precluded'' finding for a given species. The Conference Report accompanying Public Law 97-304, which established the current statutory deadlines for listing and the warranted-but-precluded finding requirements that are currently contained in the Act, states (in a discussion on 90–day petition findings that by its own terms also covers 12–month findings) that the deadlines were ''not intended to allow the Secretary to delay commencing the rulemaking process for any reason other than that the existence of pending or imminent proposals to list species subject to a greater degree of threat would make allocation of resources to such a petition [i.e., for a lower-ranking species] unwise.''

In FY 2010, expeditious progress is that amount of work that can be achieved with $10,471,000, which is the amount of money that Congress appropriated for the Listing Program (that is, the portion of the Listing Program funding not related to critical habitat designations for species that are already listed). However these funds are not enough to fully fund all our court-ordered and statutory listing actions in FY 2010, so we are using $1,114,417 of our critical habitat subcap funds in order to work on all of our required petition findings and listing determinations. This brings the total amount of funds we have for listing actions in FY 2010 to $11,585,417. Our process is to make our determinations of preclusion on a nationwide basis to ensure that the species most in need of listing will be addressed first and also because we allocate our listing budget on a nationwide basis. The $11,585,417 is being used to fund work in the following categories: compliance with court orders and court-approved settlement agreements requiring that petition findings or listing determinations be completed by a specific date; section 4 (of the Act) listing actions with absolute statutory deadlines; essential litigation-related, administrative, and listing program-management functions; and high-priority listing actions for some of our candidate species. In 2009, the responsibility for listing foreign species under the Act was transferred from the Division of Scientific Authority, International Affairs Program, to the Endangered Species Program. Starting in FY 2010, a portion of our funding is being used to work on the actions described above as they apply to listing actions for foreign species. This has the potential to further reduce funding available for domestic listing actions, although there are currently no foreign species issues included in our high priority listing actions at this time. The allocations for each specific listing action are identified in the Service's FY 2010 Allocation Table (part of our administrative record).

In FY 2007, we had more than 120 species with a Listing Priority Number (LPN) of 2, based on our September 21, 1983, guidance for assigning an LPN for each candidate species (48 FR 43098). Using this guidance, we assign each candidate an LPN of 1 to 12, depending on the magnitude of threats (high vs. moderate to low), immediacy of threats (imminent or nonimminent), and taxonomic status of the species (in order of priority: monotypic genus (a species that is the sole member of a genus); species; or part of a species (subspecies, DPS, or significant portion of the range)). The lower the listing priority number, the higher the listing priority (that is, a species with an LPN of 1 would have the highest listing priority).

Because of the large number of high-priority species, we further ranked the candidate species with an LPN of 2 by using the following extinction-risk type criteria: International Union for the Conservation of Nature and Natural Resources (IUCN) Red list status/rank, Heritage rank (provided by NatureServe), Heritage threat rank (provided by NatureServe), and species currently with fewer than 50 individuals, or 4 or fewer populations. Those species with the highest IUCN rank (critically endangered), the highest Heritage rank (G1), the highest Heritage threat rank (substantial, imminent threats), and currently with fewer than 50 individuals, or fewer than 4 populations, comprised a group of approximately 40 candidate species (''Top 40''). These 40 candidate species have had the highest priority to receive funding to work on a proposed listing determination. As we work on proposed and final listing rules for these 40 candidates, we are applying the ranking criteria to the next group of candidates with LPNs of 2 and 3 to determine the next set of highest priority candidate species. There currently are 56 candidate species with an LPN of 2 that have not received funding for preparation of proposed listing rules.

To be more efficient in our listing process, as we work on proposed rules for these species in the next several years, we are preparing multi-species proposals when appropriate, and these

may include species with lower priority if they overlap geographically or face the same threats as a species with an LPN of 2. In addition, available staff resources also are a factor in determining high-priority species provided with funding. Finally, proposed rules for reclassification of threatened species to endangered are lower priority, since as listed species, they are already afforded the protection of the Act and implementing regulations.

We assigned the greater sage-grouse an LPN of 8 based on our finding that the species faces threats that are of moderate magnitude and are imminent. These threats include the present or threatened destruction, modification, or curtailment of its habitat, and the inadequacy of existing regulatory mechanisms to address such threats. Under the Service's LPN Guidance, the magnitude of threat is the first criterion we look at when establishing a listing priority. The guidance indicates that species with the highest magnitude of threat are those species facing the greatest threats to their continued existence. These species receive the highest listing priority. We consider the threats that the greater sage-grouse faces to be moderate in magnitude because the threats do not occur everywhere across the range of the species at this time, and where they are occurring, they are not of uniform intensity or of such magnitude that the species requires listing immediately to ensure its continued existence. Although many of the factors we analyzed (e.g, disease, fire, urbanization, invasive species) are present throughout the range, they are not to the level that they are causing a significant threat to greater sage-grouse in some areas. Other threats are of high magnitude in some areas but are of low magnitude or nonexistent in other areas such that overall across the species' range, they are of moderate magnitude. Examples of this include: oil and gas development, which is extensive in the eastern part of the range but limited in the western portion; pinyon-juniper encroachment, which is substantial in some parts of the west but is of less concern in Wyoming and Montana; and agricultural development which is extensive in the Columbia Basin, Snake River Plain, and eastern Montana, but more limited elsewhere. While sage-grouse habitat has been lost or altered in many portions of the species' range, substantial habitat still remains to support the species in many areas of its range (Connelly *et al.* in press c, p. 23), such as higher elevation sagebrush, and areas with a low human footprint (activities sustaining human development) such as the Northern and Southern Great Basin (Leu and Hanser in press, p. 14) indicating that threats currently are not high in these areas. The species has a wide distribution across 11 western states. In addition, two strongholds of contiguous sagebrush habitat (the southwest Wyoming Basin and the Great Basin area straddling the States of Oregon, Nevada, and Idaho) contain the highest densities of males in the range of the species (Wisdom *et al.* in press, pp. 24-25; Knick and Hanser (in press, p. 17). We believe that the ability of these strongholds to maintain high densities in the presence of several threat factors is an indication that the magnitude of threats is moderate overall.

We also lack data on the actual future location of where some potential threats will occur (e.g., wind energy development exact location, location of the next wildfire). If these threats occur within unoccupied habitat, the magnitude of the threat to greater sage-grouse is greatly reduced. The likelihood that some occupied habitat will not be affected by threats in the foreseeable future leads us to consider the magnitude of threats to the greater sage-grouse as moderate. This likelihood is evidenced by our expectation that two strongholds of contiguous habitat will still remain in fifty years even though the threats discussed above will continue there.

Under our LPN Guidance, the second criterion we consider in assigning a listing priority is the immediacy of threats. This criterion is intended to ensure that the species facing actual, identifiable threats are given priority over those for which threats are only potential or that are intrinsically vulnerable but are not known to be presently facing such threats. We consider the threats imminent because we have factual information that the threats are identifiable and that the species is currently facing them in many portions of its range. These actual, identifiable threats are covered in great detail in factor A of this finding and include habitat fragmentation from agricultural activities, urbanization, increased fire frequency, invasive plants, and energy development.

The third criterion in our LPN guidance is intended to devote resources to those species representing highly distinctive or isolated gene pools as reflected by taxonomy. The greater sage-grouse is a valid taxon at the species level, and therefore receives a higher priority than subspecies or DPSs, but a lower priority than species in a monotypic genus.

We will continue to monitor the threats to the greater sage-grouse, and the species' status on an annual basis, and should the magnitude or the imminence of the threats change, we will re-visit our assessment of LPN.

Because we assigned the greater sage-grouse an LPN of 8, work on a proposed listing determination for the greater sage-grouse is precluded by work on higher priority candidate species (i.e., entities with LPN of 7 or lower); listing actions with absolute statutory, court ordered, or court-approved deadlines; and final listing determinations for those species that were proposed for listing with funds from FY 2009. This work includes all the actions listed in the tables below under expeditious progress (see Tables 13 and 14).

We also have assigned a listing priority number to the Bi-State DPS of the greater sage-grouse. As described above, under the Service's LPN Guidance, the magnitude of threat is the first criterion we look at when establishing a listing priority. The guidance indicates that species with the highest magnitude of threat are those species facing the greatest threats to their continued existence. These species receive a higher listing priority. Many of the threats to the Bi-State DPS that we analyzed are present throughout the range and currently impact the DPS to varying degrees (e.g. urbanization, invasive grasses, habitat fragmentation from existing infrastructure), and will continue into the future. The northern extent of the Bi-State area including the Pine Nut, Desert Creek–Fales, and Mount Grant PMUs are now and will continue to be most at risk. We anticipate loss of some local populations, and contraction of the range of others which would leave them susceptible to extirpation from stochastic events, such as wildfire, drought, and disease. Occupied habitat will continue to be affected by threats in the future and we expect that only two isolated populations in the Bodie and South Mono PMUs may remain in thirty years. The threats that are of high magnitude include: the present or threatened destruction, modification or curtailment of its habitat and range; the inadequacy of existing regulatory mechanisms; and other natural or manmade factors affecting the DPS's continued existence, such as the small size of the DPS (in terms of both the number of individual populations and their size) which increases the risk of extinction, particularly for the smaller local populations. Also the small number and size and isolation of the populations may magnify the impact of the other threats. We consider disease

and predation to be relatively low magnitude threats compared to other existing threats.

The Bi-State DPS of the greater sage-grouse is composed of approximately 35 active leks representing 4 to 8 individual local populations, based on current information on genetics and connectivity. While some of the threats do not occur everywhere across the range of the DPS at this time (e.g. habitat-based impacts from wildfire, WNv infections), where threats are occurring, the risk they pose to the DPS may be exacerbated and magnified due to the small number and size and isolation of local populations within the DPS. We acknowledge that we lack data on the precise future location of where some impacts will manifest on the landscape (e.g., effects of climate change, location of the next wildfire). To the extent to which these impacts occur within unoccupied habitat, the magnitude of the threat to the Bi-State DPS is reduced. However, to the extent these impacts occur within habitat used by greater sage-grouse, due to the low number of populations and small size of most of them, the effects to the DPS may be greatly magnified. Due to the scope and scale of the high magnitude threats and current and anticipated future loss of habitat and isolation of already small populations, leads us to determine that the magnitude of threats to the Bi-State DPS of the greater sage-grouse is high.

Under our LPN Guidance, the second criterion we consider in assigning a listing priority is the immediacy of threats. This criterion is intended to ensure that the species facing actual, identifiable threats are given priority over those for which threats are only potential or that are intrinsically vulnerable but are not known to be presently facing such threats. We have factual information the threats imminent because we have factual information that the threats are identifiable and that the DPS is currently facing them in many areas of its range. In particular these actual, identifiable threats are covered in great detail in factor A of this finding and include habitat fragmentation and destruction due to urbanization, infrastructure (e.g. fences, powerlines, and roads), mining, energy development, grazing, invasive and exotic species, pinyon–juniper encroachment, recreation, and wildfire. Therefore, based on our LPN Policy the threats are imminent (ongoing).

The third criterion in our LPN guidance is intended to devote resources to those species representing highly distinctive or isolated gene pools as reflected by taxonomy. We have determined the Bi-State greater sage-grouse population to be a valid DPS according to our DPS Policy. Therefore under our LPN guidance, the Bi-State DPS of the greater sage-grouse is assigned a lower priority than a species in a monotypic genus or a full species that faces the same magnitude and imminence of threats.

Therefore, we assigned the Bi-State DPS of the greater sage-grouse an LPN of 3 based on our determination that the DPS faces threats that are overall of high magnitude and are imminent (i.e. ongoing). We will continue to monitor the threats to the Bi-State DPS of the greater sage-grouse, and the DPS' status on an annual basis, and should the magnitude or the imminence of the threats change, we will re-visit our assessment of LPN.

Because we assigned the Bi-State DPS of the greater sage-grouse an LPN of 3, work on a proposed listing determination for this DPS is precluded by work on higher priority candidate species (i.e., entities with LPN of 2 or lower); listing actions with absolute statutory, court ordered, or court-approved deadlines; and completion of listing determinations for those species for which work already has been initiated but is not yet completed. This work includes all the actions listed in the tables below under expeditious progress (see Tables 13 and 14).

As explained above, a determination that listing is warranted but precluded also must demonstrate that expeditious progress is being made to add or remove qualified species to and from the Lists of Endangered and Threatened Wildlife and Plants. (Although we do not discuss it in detail here, we also are making expeditious progress in removing species from the list under the Recovery Program, which is funded by a separate line item in the budget of the Endangered Species Program. As explained above in our description of the statutory cap on Listing Program funds, the Recovery Program funds and actions supported by them cannot be considered in determining expeditious progress made in the Listing Program.) As with our ''precluded'' finding, expeditious progress in adding qualified species to the Lists is a function of the resources available and the competing demands for those funds. Given that limitation, we find that we are making progress in FY 2010 in the Listing Program. This progress included preparing and publishing the following determinations (Table 13):

TABLE 13—FISCAL YEAR 2010 COMPLETED LISTING ACTIONS.

Publication Date	Title	Actions	FR Pages
10/08/2009	Listing *Lepidium papilliferum* (Slickspot Peppergrass) as a Threatened Species Throughout Its Range	Final Listing Threatened	74 FR 52013-52064
10/27/2009	90-day Finding on a Petition To List the American Dipper in the Black Hills of South Dakota as Threatened or Endangered	Notice of 90–day Petition Finding, Not substantial	74 FR 55177-55180
10/28/2009	Status Review of Arctic Grayling *(Thymallus arcticus*) in the Upper Missouri River System	Notice of Intent to Conduct Status Review	74 FR 55524-55525
11/03/2009	Listing the British Columbia Distinct Population Segment of the Queen Charlotte Goshawk Under the Endangered Species Act: Proposed rule.	Proposed Listing Threatened	74 FR 56757-56770
11/03/2009	Listing the Salmon-Crested Cockatoo as Threatened Throughout Its Range with Special Rule	Proposed Listing Threatened	74 FR 56770-56791

TABLE 13—FISCAL YEAR 2010 COMPLETED LISTING ACTIONS.—Continued

Publication Date	Title	Actions	FR Pages
11/23/2009	Status Review of Gunnison sage-grouse (*Centrocercus minimus*)	Notice of Intent to Conduct Status Review	74 FR 61100-61102
12/03/2009	12-Month Finding on a Petition to List the Black-tailed Prairie Dog as Threatened or Endangered	Notice of 12 month petition finding, Not warranted	74 FR 63343-63366
12/03/2009	90-Day Finding on a Petition to List Sprague's Pipit as Threatened or Endangered	Notice of 90–day Petition Finding, Substantial	74 FR 63337-63343
12/15/2009	90-Day Finding on Petitions To List Nine Species of Mussels From Texas as Threatened or Endangered With Critical Habitat	Notice of 90–day Petition Finding, Substantial	74 FR 66260-66271
12/16/2009	Partial 90-Day Finding on a Petition to List 475 Species in the Southwestern United States as Threatened or Endangered With Critical Habitat; Proposed Rule	Notice of 90–day Petition Finding, Not substantial and Substantial	74 FR 66865-66905
12/17/2009	12–month Finding on a Petition To Change the Final Listing of the Distinct Population Segment of the Canada Lynx To Include New Mexico	Notice of 12 month petition finding, Warranted but precluded	74 FR 66937-66950
1/05/2010	Listing Foreign Bird Species in Peru and Bolivia as Endangered Throughout Their Range	Proposed ListingEndangered	75 FR 605-649
1/05/2010	Listing Six Foreign Birds as Endangered Throughout Their Range	Proposed ListingEndangered	75 FR 286-310
1/05/2010	Withdrawal of Proposed Rule to List Cook's Petrel	Proposed rule, withdrawal	75 FR 310-316
1/05/2010	Final Rule to List the Galapagos Petrel and Heinroth's Shearwater as Threatened Throughout Their Ranges	Final Listing Threatened	75 FR 235-250
1/20/2010	Initiation of Status Review for *Agave eggersiana* and *Solanum conocarpum*	Notice of Intent to Conduct Status Review	75 FR 3190-3191
2/09/2010	12–month Finding on a Petition to List the American Pika as Threatened or Endangered; Proposed Rule	Notice of 12 month petition finding, Not warranted	75 FR 6437-6471
2/25/2010	12-Month Finding on a Petition To List the Sonoran Desert Population of the Bald Eagle as a Threatened or Endangered Distinct Population Segment	Notice of 12 month petition finding, Not warranted	75 FR 8601-8621
2/25/2010	Withdrawal of Proposed Rule To List the Southwestern Washington/Columbia River Distinct Population Segment of Coastal Cutthroat Trout (*Oncorhynchus clarki clarki*) as Threatened	Withdrawal of Proposed Rule to List	75 FR 8621-8644

Our expeditious progress also includes work on listing actions that we funded in FY 2010, and for which work is ongoing but not yet completed to date. These actions are listed below (Table 14). Actions in the top section of the table are being conducted under a deadline set by a court. Actions in the middle section of the table are being conducted to meet statutory timelines, that is, timelines required under the Act. Actions in the bottom section of the table are high-priority listing actions. These actions include work primarily on species with an LPN of 2, and selection of these species is partially based on available staff resources, and when appropriate, include species with a lower priority if they overlap geographically or have the same threats as the species with the high priority. Including these species together in the same proposed rule results in considerable savings in time and funding, as compared to preparing separate proposed rules for each of them in the future.

TABLE 14—LISTING ACTIONS FUNDED IN FISCAL YEAR 2010 BUT NOT YET COMPLETED.

Species	Action
Actions Subject to Court Order/Settlement Agreement	
6 Birds from Eurasia	Final listing determination

TABLE 14—LISTING ACTIONS FUNDED IN FISCAL YEAR 2010 BUT NOT YET COMPLETED.—Continued

Species	Action
Flat-tailed horned lizard	Final listing determination
6 Birds from Peru	Proposed listing determination
Sacramento splittail	Proposed listing determination
Mono basin sage-grouse	12–month petition finding
Greater sage-grouse	12–month petition finding
Big Lost River whitefish	12–month petition finding
White-tailed prairie dog	12–month petition finding
Gunnison sage-grouse	12–month petition finding
Wolverine	12–month petition finding
Arctic grayling	12–month petition finding
Agave eggergsiana	12–month petition finding
Solanum conocarpum	12–month petition finding
Mountain plover	12–month petition finding
Hermes copper butterfly	90–day petition finding
Thorne's hairstreak butterfly	90–day petition finding
Actions with Statutory Deadlines	
48 Kauai species	Final listing determination
Casey's June beetle	Final listing determination
Georgia pigtoe, interrupted rocksnail, and rough hornsnail	Final listing determination
2 Hawaiian damselflies	Final listing determination
African penguin	Final listing determination
3 Foreign bird species (Andean flamingo, Chilean woodstar, St. Lucia forest thrush)	Final listing determination
5 Penguin species	Final listing determination
Southern rockhopper penguin – Campbell Plateau population	Final listing determination
5 Bird species from Colombia and Ecuador	Final listing determination
7 Bird species from Brazil	Final listing determination
Queen Charlotte goshawk	Final listing determination
Salmon crested cockatoo	Proposed listing determination
Black-footed albatross	12–month petition finding
Mount Charleston blue butterfly	12–month petition finding
Least chub[1]	12–month petition finding
Mojave fringe-toed lizard[1]	12–month petition finding
Pygmy rabbit (rangewide)[1]	12–month petition finding
Kokanee – Lake Sammamish population[1]	12–month petition finding
Delta smelt (uplisting)	12–month petition finding
Cactus ferruginous pygmy-owl[1]	12–month petition finding

TABLE 14—LISTING ACTIONS FUNDED IN FISCAL YEAR 2010 BUT NOT YET COMPLETED.—Continued

Species	Action
Tucson shovel-nosed snake[1]	12–month petition finding
Northern leopard frog	12–month petition finding
Tehachapi slender salamander	12–month petition finding
Coqui Llanero	12–month petition finding
Susan's purse-making caddisfly	12–month petition finding
White-sided jackrabbit	12–month petition finding
Jemez Mountains salamander	12–month petition finding
Dusky tree vole	12–month petition finding
Eagle Lake trout[1]	12–month petition finding
29 of 206 species	12–month petition finding
Desert tortoise – Sonoran population	12–month petition finding
Gopher tortoise – eastern population	12–month petition finding
Amargosa toad	12–month petition finding
Wyoming pocket gopher	12–month petition finding
Pacific walrus	12–month petition finding
Wrights marsh thistle	12–month petition finding
67 of 475 southwest species	12–month petition finding
9 Southwest mussel species	12–month petition finding
14 parrots (foreign species)	12–month petition finding
Southeastern pop snowy plover & wintering pop. of piping plover[1]	90–day petition finding
Eagle Lake trout[1]	90–day petition finding
Berry Cave salamander[1]	90–day petition finding
Ozark chinquapin[1]	90–day petition finding
Smooth-billed ani[1]	90–day petition finding
Bay Springs salamander[1]	90–day petition finding
Mojave ground squirrel[1]	90–day petition finding
32 species of snails and slugs[1]	90–day petition finding
Calopogon oklahomensis[1]	90–day petition finding
Striped newt[1]	90–day petition finding
Southern hickorynut[1]	90–day petition finding
42 snail species	90–day petition finding
White-bark pine	90–day petition finding
Puerto Rico harlequin	90–day petition finding
Fisher – Northern Rocky Mtns. population	90–day petition finding
Puerto Rico harlequin butterfly[1]	90–day petition finding
42 snail species (Nevada & Utah)	90–day petition finding
HI yellow-faced bees	90–day petition finding

TABLE 14—LISTING ACTIONS FUNDED IN FISCAL YEAR 2010 BUT NOT YET COMPLETED.—Continued

Species	Action
Red knot *roselaari* subspecies	90–day petition finding
Honduran emerald	90–day petition finding
Peary caribou	90–day petition finding
Western gull-billed tern	90–day petition finding
Plain bison	90–day petition finding
Giant Palouse earthworm	90–day petition finding
Mexican gray wolf	90–day petition finding
Spring Mountains checkerspot butterfly	90–day petition finding
Spring pygmy sunfish	90–day petition finding
San Francisco manzanita	90–day petition finding
Bay skipper	90–day petition finding
Unsilvered fritillary	90–day petition finding
Texas kangaroo rat	90–day petition finding
Spot-tailed earless lizard	90–day petition finding
Eastern small-footed bat	90–day petition finding
Northern long-eared bat	90–day petition finding
Prairie chub	90–day petition finding
10 species of Great Basin butterfly	90–day petition finding
High Priority Listing Actions[3]	
19 Oahu candidate species[3] (16 plants, 3 damselflies) (15 with LPN = 2, 3 with LPN = 3, 1 with LPN =9)	Proposed listing
17 Maui-Nui candidate species[3] (14 plants, 3 tree snails) (12 with LPN = 2, 2 with LPN = 3, 3 with LPN = 8)	Proposed listing
Sand dune lizard[3] (LPN = 2)	Proposed listing
2 Arizona springsnails[3] *(Pyrgulopsis bernadina* (LPN = 2), *Pyrgulopsis trivialis* (LPN = 2))	Proposed listing
2 New Mexico springsnails[3] *(Pyrgulopsis chupaderae* (LPN = 2), *Pyrgulopsis thermalis* (LPN = 11))	Proposed listing
2 mussels[3] (rayed bean (LPN = 2), snuffbox No LPN)	Proposed listing
2 mussels[3] (sheepnose (LPN = 2), spectaclecase (LPN = 4),)	Proposed listing
Ozark hellbender[2] (LPN = 3)	Proposed listing
Altamaha spinymussel[3] (LPN = 2)	Proposed listing
5 southeast fish[3] (rush darter (LPN = 2), chucky madtom (LPN = 2), yellowcheek darter (LPN = 2), Cumberland darter (LPN = 5), laurel dace (LPN = 5))	Proposed listing
8 southeast mussels (southern kidneyshell (LPN = 2), round ebonyshell (LPN = 2), Alabama pearlshell (LPN = 2), southern sandshell (LPN = 5), fuzzy pigtoe (LPN = 5), Choctaw bean (LPN = 5), narrow pigtoe (LPN = 5), and tapered pigtoe (LPN = 11))	Proposed listing

TABLE 14—LISTING ACTIONS FUNDED IN FISCAL YEAR 2010 BUT NOT YET COMPLETED.—Continued

Species	Action
3 Colorado plants[3] (Pagosa skyrocket *(Ipomopsis polyantha*) (LPN = 2), Parachute beardtongue *(Penstemon debilis*) (LPN = 2), Debeque phacelia *(Phacelia submutica*) (LPN = 8))	Proposed listing

[1] Funds for listing actions for these species were provided in previous FYs.
[2] We funded a proposed rule for this subspecies with an LPN of 3 ahead of other species with LPN of 2, because the threats to the species were so imminent and of a high magnitude that we considered emergency listing if we were unable to fund work on a proposed listing rule in FY 2008.
[3] Funds for these high-priority listing actions were provided in FY 2008 or 2009

We have endeavored to make our listing actions as efficient and timely as possible, given the requirements of the relevant laws and regulations, and constraints relating to workload and personnel. We are continually considering ways to streamline processes or achieve economies of scale, such as by batching related actions together. Given our limited budget for implementing section 4 of the Act, the actions described above collectively constitute expeditious progress.

The greater sage-grouse and the Bi-State DPS of the greater sage-grouse will each be added to the list of candidate species upon publication of these 12–month findings. We will continue to monitor their status as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures. We acknowledge we must reevaluate the status of the Columbia Basin population as it relates to the greater sage-grouse; we will conduct this analysis as our priorities allow. Other populations of the greater sage-grouse, as appropriate, will be evaluated to determine if they meet the distinct population segment (DPS) policy prior to a listing action, if necessary and appropriate.

We intend that any proposed listing action for the greater sage-grouse or Bi-State DPS of the greater sage-grouse will be as accurate as possible. Therefore, we will continue to accept additional information and comments from all concerned governmental agencies, the scientific community, industry, or any other interested party concerning these findings.

References Cited

A complete list of references cited is available on the Internet at *http://www.regulations.gov* and upon request from the Wyoming Ecological Services Office (see ADDRESS section).

Author

The primary authors of this notice are the staff members of the Wyoming, Montana, Idaho, Nevada, and Oregon Ecological Services Offices.

Authority: The authority for this section is section 4 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Dated: March 3, 2010

Daniel M Ashe,

Acting Director, Fish and Wildlife Service

[FR Doc. 10–?????? Filed ??–??– 10; 8:45 am]

BILLING CODE 4310–55–S

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
WASHINGTON, D.C. 20240
http://www.blm.gov/

March 5, 2010

In Reply Refer To:
1110 (230/300) P

EMS TRANSMISSION 03/05/2010
Instruction Memorandum No. 2010-071
Expires: 09/30/2011

To: All Field Officials

From: Director

Subject: Gunnison and Greater Sage-grouse Management Considerations for Energy Development (Supplement to *National Sage-Grouse Habitat Conservation Strategy*)

Program Areas: Oil and Gas, Oil Shale, Geothermal, Wind, Solar, and Associated Rights-of-Way, Wildlife, Land Use Planning, National Environmental Policy Act.

Purpose: This Instruction Memorandum (IM) supplements the Bureau of Land Management's (BLM) 2004 *National Sage-Grouse Habitat Conservation Strategy* (BLM National Strategy). The BLM is issuing this IM in light of—

- recent peer-reviewed scientific studies addressing the impacts of oil and gas development on sage-grouse;
- the currently limited information available concerning the impacts of wind energy development on sage-grouse; and
- the increasing land use pressures on the public lands, including the BLM's authorization of renewable energy projects.

This IM identifies management actions necessary at some sites to ensure environmentally responsible exploration, authorization, leasing, and development of renewable and non-renewable energy resources within the ranges of the Gunnison sage-grouse and greater sage-grouse.

On March 5, 2010, the U.S. Fish and Wildlife Service announced that listing of the greater sage-grouse as an endangered species under the Endangered Species Act (ESA) is warranted, but listing is precluded by the need to complete other listing actions of higher priority. In view of this finding, it is of even greater importance that the BLM continue to work to improve the BLM National Strategy. This IM, focusing on energy development, is another step in that direction. When a range-wide "priority" or "core" sage-grouse habitat map is developed and as additional research on threats to sage-grouse other than energy development becomes available, the BLM will issue a more comprehensive Bureau-wide policy directive. The BLM will continue to work with its partners—the Western Association of Fish and Wildlife Agencies (WAFWA), U.S. Fish and Wildlife Service, U.S. Geological Survey, Natural Resources Conservation Service, U.S. Forest Service, and the Farm Service Agency—within the framework of the partners' Sagebrush Memorandum of Understanding (2008) (Sagebrush MOU) and the *Greater Sage-Grouse Comprehensive Conservation Strategy* (2006) (Multiagency Strategy).

Policy / Action: The Gunnison sage-grouse and greater sage-grouse are BLM sensitive species that are to be managed to promote their conservation and to minimize the need for listing

under the ESA, in accordance with the BLM's special status species policy (BLM Manual 6840). Therefore, when necessary to maintain sustainable sage-grouse populations across the broader landscape within the state, field managers will implement an appropriate combination of the following actions in "priority habitat."

Generally speaking, "priority habitat" is the habitat of highest conservation value relative to maintaining sustainable sage-grouse populations range-wide. Priority habitat will be areas of high quality habitat supporting important sage-grouse populations, including those populations that are vulnerable to localized extirpation but necessary to maintain range-wide connectivity and genetic diversity.

I. Actions Available for Protection of Sage-grouse Populations

Oil and Gas/Geothermal:

- Withhold from sale or defer the sale of parcels, in whole or in part, that industry has proposed for oil and gas or geothermal leasing in priority habitat as supported by analysis under the National Environmental Policy Act (NEPA) of the impacts of leasing on sage-grouse.
- If parcels are offered for sale in sage-grouse priority habitat, attach a lease notice to new leases alerting the lessee that additional conditions will be applied to approvals to develop to the lease, including Applications for Permit to Drill (APDs), sundry notices and associated rights-of-way, if future sage-grouse conservation efforts are appropriate.
- In priority habitat and where supported by NEPA analysis, attach conditions to the approval of APDs that are more protective than the stipulations or restrictions identified in the applicable Resource Management Plan (RMP), as appropriate.

Oil Shale:

- Screen new oil shale lease applications to identify whether the proposed leasing area includes priority habitat. If so, alert the applicant as early as possible that, pending NEPA analysis, the application may be delayed or denied or that lease stipulations and project conditions of approval may be imposed that designate avoidance areas or include No Surface Occupancy restrictions, for example.

Wind and Solar Energy Development and Associated Site Testing:

- Screen new right-of-way applications to identify whether the wind or solar energy development or site testing and project area includes priority habitat. If so, alert the applicant as early as possible that the application may be denied or that terms and conditions may be imposed on the right-of-way grant to protect priority habitat as supported by NEPA analysis.

Transmission:

- Re-route proposed transmission projects to avoid priority habitat.

RMP Revisions/Amendments:

- In RMP revisions and amendments, analyze one or more alternatives that would exclude priority habitat from energy development and transmission projects.

The BLM will consider how projects can avoid, minimize, and mitigate impacts onsite. However, the BLM may condition approval of a project proposal upon additional onsite modification or additional mitigation, including offsite mitigation.

Both the BLM and the state fish and wildlife agencies recognize that priority habitat has not been identified range-wide utilizing a consistent methodology. Until the BLM has fully engaged its state fish and wildlife agency counterparts in the mapping of priority habitat, the BLM will identify priority habitat using RMPs, state-led and Local Working Group sage-grouse plans, peer-reviewed literature, conservation plans or agreements, and professional judgment.

II. Future Actions for the Protection of Sage-grouse Populations

Further action that will help to develop a comprehensive Bureau-wide policy for the protection of sage-grouse populations and the conservation of habitat on a landscape scale will be pursued in the near future. These efforts will be undertaken within the collaborative framework established by the Sagebrush MOU and the Multiagency Strategy. Specifically, the following steps will be taken after issuance of this IM:

- The BLM will continue to work with the state fish and wildlife agencies, using a consistent protocol, to delineate and map areas of high priority habitat across the ranges of Gunnison sage-grouse and greater sage-grouse. This map will serve as a platform for a more directed Bureau-wide sage-grouse policy, similar to the approach already taken in Wyoming.
- Upon completion of a range-wide priority habitat map described above, each BLM State Office, working in coordination with the respective state fish and wildlife agency, will identify state-specific management actions (not limited to energy development) on a landscape level that will be undertaken both inside and outside of identified priority habitat in order to maintain sustainable sage-grouse populations.

Protection of sage-grouse populations and habitat is of critical importance, and several BLM State Offices have extensive sage-grouse conservation plans that were developed cooperatively with state fish and wildlife directors and stakeholder groups. In taking the steps listed above, the BLM will work diligently to ensure that it addresses local efforts or situations.

Timeframe: This IM is effective immediately.

Budget Impact: This IM will result in additional costs for mapping, coordination, NEPA review, and monitoring.

Background: It is imperative that fragmentation and degradation of Gunnison sage-grouse and greater sage-grouse habitat not continue to the point that sustainable sage-grouse populations can no longer be supported. In November 2004, the BLM published the BLM National Strategy. The BLM National Strategy set goals and objectives and assembled guidance and resource materials. It also provided comprehensive management direction for the BLM's contributions to the ongoing multi-state sage-grouse conservation effort, in cooperation with WAFWA. This IM reflects continued implementation of the goals set forth in the BLM National Strategy.

Although the focus of this IM is energy development, energy development is not the only or necessarily the most significant threat to Gunnison or greater sage-grouse. The purpose of this IM is to highlight management actions affecting sage-grouse habitat that will be necessary to sustain sage-grouse populations in light of new information and the Department of the Interior's energy-related priorities.

Since completion of the BLM National Strategy, additional peer-reviewed research analyzing the impacts of oil and gas development on greater sage-grouse has become available. Some aspects of oil and gas development affecting sage-grouse use of an area (e.g., construction of facilities, road networks, and resulting habitat fragmentation) also occur in other types of

energy development. In addition, while not specific to Gunnison sage-grouse or greater sage-grouse, other research has been completed on the impacts of wind energy development on prairie chickens that is applicable to closely related species such as Gunnison and greater sage-grouse. The BLM will consider this body of research in the context of all energy development activities on the public lands.

The Mineral Leasing Act (Act or MLA) provides that all lands subject to the Act "which are known or believed to contain oil or gas deposits may be leased by the Secretary [of the Interior]." 30 U.S.C. 226(a) (2009). The Supreme Court held that the Act gives the Secretary broad discretion not to offer an oil and gas tract for leasing. *Udall v. Tallman*, 380 U.S. 1, 4 (1965). The U.S. Court of Appeals for the Ninth Circuit held that refusing to issue leases is a legitimate exercise of the Secretary's discretion under the MLA (*see Burglin v. Morton*, 527 F.2d 486, 488 (9th Cir. 1975) (citing *Tallman*, 380 U.S. at 4)). The Interior Board of Land Appeals has expressly held that lands identified for oil and gas leasing in an RMP are open for permissible uses, and the BLM has no duty to offer them for lease, even when the BLM has received a pre-sale non-competitive offer to lease (*Richard D. Sawyer*, 160 IBLA 158, 163 (2003)) or a nomination for competitive lease (*Marathon Oil Co.*, 139 IBLA 347 (1997)). The BLM may also decline to lease even after the BLM has received bids and bonus monies at a competitive lease sale (*Continental Land Resources*, 162 IBLA 1, 14-15 (2004)). The IBLA has also upheld the BLM's authority to impose more stringent protection measures on approval of development plans or permits than provided for in lease stipulations when supported by current science and analyzed through the NEPA process (*see William P. Maycock*, 177 IBLA 1 (2009); *Yates Petroleum Corp.*, 176 IBLA 144 (2008)).

Title V of the Federal Land Policy and Management Act, 43 U.S.C. 1761-1771, authorizes the Secretary to grant rights-of-way over, upon, under, or through the public lands for a variety of purposes, such as roads, water pipelines, systems for generation of electric energy, and communication systems. The IBLA has held that a decision to issue a right-of-way is discretionary. (*Mark Patrick Heath,* 161 IBLA 381, 388 (2004)). The discretionary nature of a right-of-way grant is underscored by BLM regulations at 43 CFR 2804.26, which provide that an application for a right-of-way may be denied if the proposed use would not be in the public interest.

Coordination: This IM was coordinated with the Assistant Director, Renewable Resources and Planning (WO-200), the Assistant Director, Minerals and Realty Management (WO-300), and BLM Deputy State Directors.

Contact: State Directors may direct any questions or concerns to Michael D. Nedd, Assistant Director, Minerals and Realty Management (WO-300), at 202-208-4201 or mike_nedd@blm.gov, and Edwin Roberson, Assistant Director, Renewable Resources and Planning (WO-200), at 202- 208-4896 or edwin_roberson@blm.gov.

Signed by:
Robert V. Abbey
Director

Authenticated by:
Robert M. Williams
Division of IRM Governance,WO-560

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
5353 Yellowstone Road, Suite 308A
Cheyenne, Wyoming 82009

In Reply Refer To:
ES-61411/WY11TA0044

November 10, 2010

Mr. Ryan M. Lance
Deputy Chief of Staff
Office of the Governor
State Capitol
Cheyenne, Wyoming 82002

Dear Mr. Lance:

Thank you for your letter of September 20, 2010, regarding the refined core population area strategy developed and revised by the Governor's Sage Grouse Implementation Team (Implementation Team) for the conservation of the Greater sage-grouse in Wyoming (Revised Strategy). Governor Freudenthal requested the U.S. Fish and Wildlife Service's (Service) professional evaluation of the Revised Strategy, with particular focus on four questions discussed in detail below. We commend the work of the State of Wyoming and the Implementation Team in producing the Revised Strategy and for the continuing commitment to ensure the conservation of this iconic Wyoming species. This long-term, science-based vision for the conservation of greater sage-grouse has set the stage for similar conservation efforts across the species' range.

The Service believes the Revised Strategy can result in the long-term conservation of the Greater sage-grouse and thus reduce the need to list the species under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.). If fully implemented, we believe the Revised Strategy can provide the conservation program necessary to achieve your goal of precluding listing of the Greater sage-grouse in Wyoming. The specific questions in your letter provide an opportunity to discuss aspects of implementing the Revised Strategy that are the key to its success and may determine if it fulfills your ultimate goal.

Your first specific question asks if the "…core population area strategy, as outlined in Executive Order 2010-4, remain a sound policy for manage sage-grouse populations in Wyoming. We believe the Implementation Team's June 28, 2010 letter to the Governor and the resulting Executive Order 2010-4 is a sound policy framework by which to conserve Greater sage-grouse in Wyoming. As we stated in our March 23, 2010 status determination for the Greater sage-grouse (Decision; 75 FR 13910) "the Service believes that the core area strategy … if implemented by all landowners via regulatory mechanisms, would provide

adequate protection for sage-grouse and their habitat in that State." This is a critical point and remains true for the Revised Strategy. To be effective State, Federal and private landowners must all implement this strategy.

Another concern for the long-term policy effectiveness of the Revised Strategy is that the core population areas reflect key breeding habitats only. As discussed at the Implementation Team meetings, the Service believes that the core population areas need to include other important seasonal habitats as they are identified. The Implementation Team actively engaged this topic throughout the revision process, but due to lack of information on the location of those habitats left the final resolution to local working groups once data become available. While we support the development of local solutions to address the protection of seasonal habitats as they are identified, these local solutions must be based on sound scientific data. It is also critical that the protections for seasonal habitats address the real conservation concerns for these potentially limiting habitat areas. As evidenced by recent scientific publications (e.g., see Carpenter *et al*. 2010), habitats other than breeding can in fact be limiting to sage-grouse populations, and thus the implementation of the Revised Strategy will need to keep current with the best available science in order to meet the information requirements of the Act (section 4(b)(1)(A)). Additionally, local solutions need to have mechanisms to ensure they will in fact be implemented, for example be regulatory in nature to the extent practicable. We are also concerned that there will be a diverse variety in solutions identified for the protection of seasonal habitats, which may be biologically appropriate, but confusing in application. Therefore, we encourage continued discussion of these solutions at the State level to minimize potential confusion and inconsistent application, and maximize conservation effectiveness.

The second question in your letter requested review of the transmission corridor management outlined in Executive Order 2010-4. Given the demand for increased electrical transmission capacity within and across Wyoming this is a very important topic. Specifically, you asked if we agreed "…with the State's premise that the best way to manage impacts to sage-grouse is to co-locate new transmission infrastructure with existing lines in the corridors set forth in the Executive Order". The Service does agree with this premise. As clearly defined in our Decision, habitat loss and fragmentation was the primary factor contributing to the Greater sage-grouse warranted status. Transmission corridors contribute to habitat fragmentation; therefore any efforts to consolidate that infrastructure, particularly new infrastructure, will minimize the effects of future transmission development on Greater sage-grouse. We urge you, and all partners on the Implementation Team, to insure that designated corridors through core areas do not increase in width beyond those designated in the Executive order (½-mile either side of existing 115 kV or larger transmission lines, or the designated 2-mile wide corridors in some core areas). Failure to contain these corridors will eventually result in the division of core areas (particularly if the size and capacity of transmission lines increase), compromising Greater sage-grouse habitat quality and population stability.

Your third specific question asked if permitting pursuant to the Surface Mining Control and Reclamation Act (SMCRA) is adequate to protect sage-grouse in core areas. The provisions for conservation of Federal trust species, including candidates such as Greater sage-grouse, under SMCRA and its implementing regulations, are sufficient for conservation of this species.

However, the implementation of the SMCRA provisions will determine their adequacy in relation to the Revised Strategy. The Office of Surface Mining (OSM), the Federal agency responsible for implementation and enforcement of SMCRA, has delegated authority to the Wyoming Department of Environmental Quality, Land Quality Division (DEQ), for regulating coal mine activities in the State. This delegation of authority places the burden on the State regulatory agency to meet the requirements of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*), including implementation of the provisions of the 1996 biological opinion between OSM and the Service. It will be important for DEQ to thoroughly implement all the provisions of SMCRA, associated implementing regulations, and the 1996 biological opinion. Since DEQ does not have a wildlife biologist on staff, they typically rely on other State and Federal agencies to address that need. However, we are concerned that this approach may not always sufficient to adequately address concerns that may affect the Greater sage-grouse. We encourage you to identify ways in which DEQ can ensure that they are able to adequately implement SMCRA provisions in relation sage-grouse conservation. One potential solution may be to include at least one wildlife biologist who is knowledgeable of SMCRA, the Act, and the 1996 biological opinion, in each of three regional DEQ offices.

Your final specific question regarded what the State of Wyoming could do outside the auspices of the Executive Order to ensure that the sage-grouse is removed from the candidate species list within this state. The Service encourages the State to continue to actively advocate for sage-grouse conservation, and perhaps more importantly, healthy sagebrush ecosystems. We recognize that the conservation of sage-grouse may involve difficult choices in prioritizing management objectives for a variety of needs within Wyoming. While we do not advocate for elimination or preclusion of any activity, we do encourage the State and project proponents to consider all alternatives that minimizes or removes impacts to the sagebrush ecosystem. We offer our assistance in these efforts if desired. Additionally, we encourage the State to continue to be active participants in the decision-making processes that affect sage-grouse and sagebrush that are conducted by land managers in Wyoming, including State agencies. We recognize the State of Wyoming's expertise in sage-grouse and encourage use of that information to inform these planning processes.

In summary, the Service believes the Core Population Area Strategy for the Greater sage-grouse provides an excellent model for meaningful conservation of sage-grouse if fully supported and implemented. We believe that when fully realized, this effort could ameliorate many threats to the greater sage-grouse. We fully recognize and appreciate your commitment and financial obligation to this important conservation effort. The Service again commends the State's leadership for your proactive and insightful efforts, and your commitment to the long-term conservation of this species.

We look forward to continuing in our participation with Wyoming in greater sage-grouse conservation. If you have any questions regarding the information provided here please do not hesitate to contact me at 307-772-2374, extension 231, or Pat Deibert of my staff at extension 226.

Sincerely,

/s/ Scott Hicks

Scott Hicks
Acting Field Supervisor
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USFS, Regional Forester (H. Forsgren)
USFS, Regional Forester (R. Cables)
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Governor's Sage Grouse Implementation Team, Chair, Lander, WY (B.Budd)

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Columbian Sharp-tailed Grouse

(Tympanuchus phasianellus columbianus)

The Columbian Sharp-tailed Grouse (*Tympanuchus phasianellus columbianus*) is one of seven subspecies of sharp-tailed grouse found in North America. Historically, Columbian Sharp-tailed Grouse occurred within sagebrush-native bunch grass habitat throughout the intermountain region, extending from British Columbia, Washington, Idaho and Montana south through portions of Oregon, California, Nevada, Utah, Wyoming, Colorado and New Mexico.

Lewis and Clark were the first to describe the Columbian subspecies of sharp-tailed grouse in the early 1800s. In 1815, a taxonomist, named Ord, officially classified the Columbian Sharp-tailed Grouse by providing it with a scientific name. Some common names for the Columbian Sharp-tailed Grouse include: sharptail, brush grouse, spiketail, pintail grouse, sprigtail, prairie grouse, speckle-belly, prairie pheasant, white-belly, white-breasted grouse, spotted chicken, prairie chicken, prairie hen and white grouse. Sharp-tailed grouse belong to the family Phasianidae within the order Galliformes ("chicken-like" birds).

The Columbian Sharp-tailed Grouse was an important source of food for many Native Americans and early settlers of the West. The elaborate courtship displays of this bird are replicated in a variety of dances performed by Native Americans.

Description

Columbian Sharp-tailed Grouse are one of six native species of grouse found within Utah. They are smaller than sage and Blue Grouse, and larger than Ruffed Grouse and White-tailed Ptarmigan. They look very much like a hen pheasant, except for a short, pointed tail and V-shaped, brown markings on cream-colored breast feathers. Early Utah settlers commonly referred to sharp-tailed grouse as prairie chickens and prairie hens.

The male or cock is about 20 inches long and the female or hen slightly smaller. Sharptails weigh from one to one and three quarters pounds. Adult male and female sharp-tailed grouse are nearly identical in plumage. Both sexes are overall grayish-brown with black and buffy markings. White, circular spots on the primary wing feathers and the barred pattern of the wing are distinctive features. The under parts are white, while breast feathers have a distinct pattern of dark, V-shaped, brown markings. The tail is wedge-shaped, with the two central tail feathers longer than the rest. This is where the sharptail gets its name. Males have purple air sacs on the sides of the neck that cannot be seen except when inflated during breeding activities.

Habitat

In Utah, sharp-tailed grouse are associated with transitional zones within sagebrush communities, ranging in elevation from the interface of aspen-sagebrush to the edge of sagebrush and desert saltbush near the Great Salt Lake. Elevation within their distribution varies from 4,300 to 8,000 feet. Their distribution overlaps that of Blue and Ruffed Grouse within aspen-mountain brush-sagebrush communities, and sage-grouse and Hungarian Partridge within sagebrush rangelands and dryland farms.

In Utah, 56 percent of the active leks, or dancing grounds, are found within sagebrush-native bunch grass habitat, 36 percent are found on Conservation Reserve Program (CRP) lands and 8 percent are on agricultural lands.

When native rangelands are used for nesting, most females nest beneath or within a few feet of a shrub. When available, sagebrush is preferred nesting habitat, although snowberry, bitterbrush, serviceberry and other mountain shrubs are also used. Within shrub habitat, females select nest sites with denser grass, forb and shrub cover than at independent sites. Studies in Utah during the 1930s to 1940s (prior to the CRP), found that within intensively cultivated areas, hens selected alfalfa or wheat stubble for nesting, although nest success was only 47 percent and 18 percent, respectively. Implementation of CRP, beginning in 1986, created extensive tracts of undisturbed nesting cover. Areas seeded with alfalfa and other forbs have developed into high quality nesting and brooding habitat. Researchers have found that nest success was higher in non-native (alfalfa and CRP) habitats (86%) compared to native habitats (53%).

Brooding habitat typically includes a high diversity of interspersed shrubs, perennial forbs and bunch grasses. On native rangelands, brood habitat typically consists of 60 to 80 percent grass/forb cover and 20 to 40 percent shrub cover. Cultivated fields, native grasslands and CRP lands are used when the density and height of vegetation provides 8 to12 inches of visual obstruction. Columbian Sharp-tailed Grouse seem to respond to livestock grazing of brooding habitat by moving to ungrazed rangelands or by concentrating in ungrazed CRP lands.

The selection of winter habitat depends primarily upon snow accumulation and the availability of feeding and roosting sites. Typical wintering areas include deciduous trees and mountain shrubs in upland and riparian areas. In Utah, grouse often move from sagebrush up to maple-chokecherry cover types as snow accumulates. If snow depths remain minimal, grouse do not move to higher elevation habitat. Generally, grouse do not have winter food problems because the browse species they use are often abundant. However, habitat alterations and land conversions have seriously reduced the quantity and quality of preferred berry and bud-producing shrubs available to sharp-tailed grouse in Utah.

Food Habits

During spring and summer, sharp-tailed grouse forage in areas dominated by dense forb and sparse grass cover. During fall and winter, birds forage on the ground in areas where succulent forbs or grains are available and on fruits and buds in areas dominated by sagebrush, trees or shrubs. In Utah studies, the major food items in the diet during the spring and summer include forbs such as clover, goldenrod, hawksbeard, dandelion, fruits, grains, grass and grass seeds. The fall and winter diet consists of the fruit, seeds and buds of native shrubs, including serviceberry, hawthorn, birch, aspen, chokecherry, wild rose, willow, snowberry, Russian olive, and the leaves of rabbit brush. Where available, sharp-tailed grouse will also use wheat, corn and barley. Insects, including ants, grasshoppers, crickets, beetles and galls from sagebrush, are eaten when available as well.

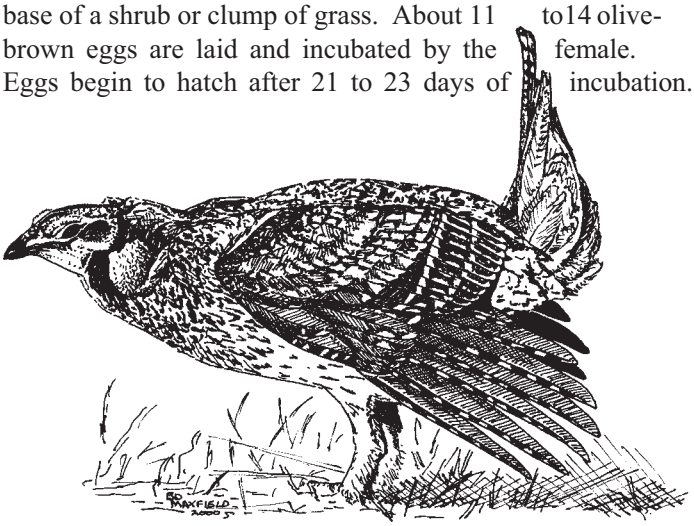
Reproductive Biology/Ecology

The breeding season for sharp-tailed grouse begins in March when males start congregating on leks (dancing grounds). The word "lek" comes from the Swedish term *lekställe* which means "mating place." Dancing grounds may be located on low ridges and knolls, recent burns, forest clearcuts, natural openings, and other areas with low sparse vegetation allowing good visibility, good acoustics and unrestricted movement. Established dancing grounds will be used for many years, although their exact location may shift over time and smaller "satellite" dancing grounds may be formed in the vicinity of historic dancing grounds. Dancing grounds form the hub of sharptail breeding habitat.

Males engage in communal courtship displays while on the dancing grounds to establish territorial boundaries and a dominance hierarchy for breeding. They display twice daily, at sunrise and shortly before sunset. With tail erect, wings lowered and neck outstretched, the males rapidly quiver their tail feathers, and slowly twist and turn while swiftly stamping their feet. Resonant gurgling sounds made by repeatedly inflating and deflating the air sacs on the sides of their neck accentuate the traditional dance. This elaborate display of dancing males attracts females to the site for mating.

The most dominant male bird, called a "master" cock, does most of the breeding of hens. Other cocks in order of dominance are called "dominant" cocks, "guard" cocks and "outsider" cocks. Breeding continues through early May.

Following breeding, females leave the dancing grounds to select a nest site. Provided suitable nesting habitat is available, most female sharp-tailed grouse nest within one and a half miles of the dancing ground site. Nesting begins in April. Nests are comprised of shallow hollows lined with grass, leaves and feathers and are usually placed near the base of a shrub or clump of grass. About 11 to14 olive-brown eggs are laid and incubated by the female. Eggs begin to hatch after 21 to 23 days of incubation.



Male Columbian Sharp-tailed Grouse performing courtship display.

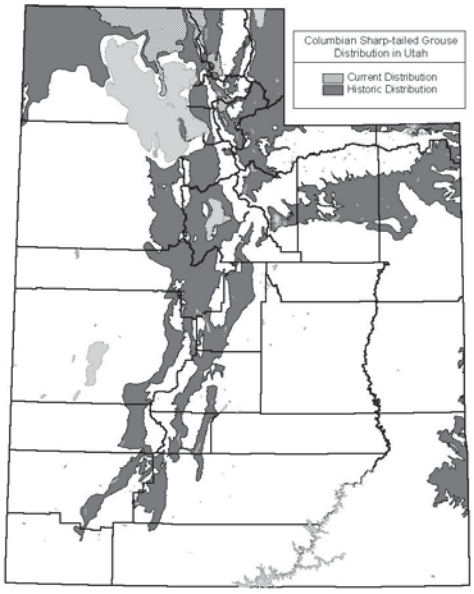
Approximately 50 to 55 percent of the nests successfully hatch. Renesting can occur if the first nest is depredated, however, a hen will only raise one brood annually. Chicks remain relatively close to the nesting area throughout the summer. CRP fields, which include alfalfa, are often used as brooding habitat for two to three weeks after hatching. Chicks feed primarily on insects, including ants, crickets, moths, grasshoppers and beetles.

Annual brood surveys conducted in Utah between 1972 to1976 and 1992 to 2000 have shown average brood sizes varied from 2.5 to 6.0 chicks per brood. The long-term average is 4.5 chicks per brood. Broods usually disperse within six to eight weeks. Successful brood-rearing is highly dependent on areas with abundant forbs and insects. The summer diet of juvenile sharptails consists of both insects and succulent plant material, whereas adults eat primarily succulent plant material.

Historical Status in Utah

Sharp-tailed grouse numbers once were more abundant in Utah due to habitat quality and quantity. An early account by Cache Valley resident Joel Ricks states that in the early 1870s, when the telegraph wire was put through Cache Valley, scores of wild chickens were killed by flying in to it. There were thousands of these chickens until about 1875 when they began to dwindle. In another historical account, Dr. W. W. Henderson of the Utah State Agricultural College in Logan reported that in the 1890s, it was not uncommon to see flocks of several hundred sharptails in northern Cache Valley, stating it would have been possible to see ten thousand in one day of riding the range.

The historical distribution of sharp-tailed grouse in Utah occurred within the sagebrush-native bunch grass region from Nevada east along the Utah-Idaho border to Wyoming.



Historical and current distribution of Columbian Sharp-tailed Grouse.

Their range extended south along the length of the Wasatch Mountains to Garfield County and east from Utah County through the Uintah Basin to Colorado. This distribution was maintained until the early 1900s, when they were reported to still be numerous in Cache, Davis, eastern Juab, Morgan, Rich, Salt Lake, Sanpete, Summit, Wasatch, Weber and Utah counties. By 1935 though, large-scale conversion of sagebrush-steppe to cropland and overgrazing by domestic livestock had significantly eliminated and impacted habitat, and the distribution of sharp-tailed grouse was greatly reduced.

Populations survived in only a few areas in the north-central portion of Utah. Within these areas, birds were restricted to remaining islands of sagebrush-steppe within dry-farmland and foothill bench pastures which had not been severely overgrazed. Scattered or isolated populations remained only in Box Elder, Cache, Morgan, Rich and Weber counties.

Current Status in Utah

As a result of habitat loss and over hunting, by 1935, grouse numbers had plummeted to the point that a survey done that same year provided a total estimated fall-winter population of only 1,500 birds. Subsequent surveys in 1939 and 1948 estimated the total population at 1,155 and 1,515 birds. Populations remained low until the mid-1970s when hunters, landowners and Utah Division of Wildlife Resources (UDWR) personnel began sighting more birds.

Since 1979, dancing ground counts have been used as an index of sharp-tailed grouse population size. Dancing ground count results indicate that population trends remained stable until the late 1980s, after which they increased.

The most graphic indication of increases in abundance of sharptails since the 1970s can be found in the results of the 1999 harvest questionnaire in which 288 hunters reported seeing 6,597 sharp-tailed grouse—an average of 20 birds per hunter-day. Data from surveys conducted during 1998 and 1999 were used to estimate a 1999 fall population of 11,153 birds.

The reason for the dramatic increase in numbers is most likely due to the federally funded Farm Bill's Conservation Reserve Program. First implemented in 1986, CRP provides a continuum of habitat that interconnects isolated core sharptail population areas and provides isolated populations opportunities to expand. As a result of CRP, overall sharptail distribution increased by approximately 400 percent from the known distribution in 1975. Because of its dependence on federal agricultural programs to keep crucial habitat out of production, some refer to the sharptail as a "Federal Bird."

Today, sharp-tailed grouse in the west are leading a precarious existence. They are doing well in certain areas, but everything can change with the sale of a field or changes in the economy.

Hunting

The Columbian Sharp-tailed Grouse is classed as an upland game species by the Utah Legislature. However, they were not hunted in Utah from 1925 to 1973. By the early 1970s, reported observations by the public and UDWR personnel indicated thatpopulations were increasing and a limited hunt was initiated in 1974. In 1979, all sharp-tailed grouse hunters were required to obtain a free permit.

Due to a decline in observations during the spring-summer inventory period, hunting was discontinued in 1980 and remained closed through 1997. Between 1998 and 2000, a limited entry hunt was authorized within a 595 square mile hunt unit in eastern Box Elder County. Fall populations within the unit were estimated at 5,757 grouse in 1998 and 7,196 grouse in 1999. Harvest levels were set at percentages that would not impact subsequent breeding densities.

Conservation Concerns

Sharp-tailed grouse throughout the western United States have been experiencing declines in the number of dancing grounds and the number of males attending dancing grounds. Although for most populations, declines can be a result of a variety of causes, the key to maintaining any species is providing sufficient habitat.

For sharp-tailed grouse, fragmentation and loss of habitat has been the result of several factors including increased building of roads, the spread of housing developments, powerline construction and the destruction of riparian areas. Degradation in quality of habitat has come as a result of excessive livestock grazing, drought and land treatments. Grazing has severely impacted the vegetative composition of sagebrush-native bunch grass habitat on foothill and bench rangelands, causing native bunch grasses to be replaced by exotic annual grasses and canopy coverage of sagebrush to become too dense. In riparian habitats many bud-producing shrubs have been eliminated or reduced.

Although most of the sagebrush-native bunch grass areas within dry-farm lands in Box Elder County is in good ecological condition and currently not grazed due to lack of water for livestock, future livestock water developments could change existing conditions. The subdivision of ranches and farms in rural areas for residential and recreational homes and other developments also threatens core populations of sharp-tailed grouse.

Basically the greatest threat to grouse populations in a general sense is the increasing human population. Most of the impacts listed above are due to our growing presence in the sagebrush ecosystem. In Utah, most people live within only a one or two hour drive of the remaining sharp-tailed grouse habitat found in the state. Only time will tell if this once plentiful and revered western bird will continue as a part of a fractured landscape.

What You Can Do

- Become an active member of a conservation organization devoted to grouse or the wise management of sagebrush/ sagebrush-steppe habitats.

- Become a member of a local working group dedicated to conservation planning efforts for the Columbian Sharp-tailed Grouse. Contact your local Division of Wildlife Resources office for information on established groups in northern Utah.

- Become more knowledgeable about various conservation programs and their renewal under the Federal Farm Bill. The Conservation Reserve Program (CRP) has provided essential habitat for grouse. Please let your congressional representatives and other leaders and decision-makers know how important these programs are to wildlife.

Additional Reading

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May , 2002

Columbian Sharp-tailed Grouse (*Tympanuchus phasianellus columbianus*): A Technical Conservation Assessment

Prepared for the USDA Forest Service, Rocky Mountain Region, Species Conservation Project

August 17, 2007

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Authors' Biographies

Richard W. Hoffman earned his B.Sc. and M.Sc. Degrees in wildlife biology from Colorado State University. He subsequently worked for the Colorado Division of Wildlife for over 30 years as an avian researcher specializing in upland game birds. He has conducted research on population dynamics, habitat relationships, nutritional ecology, and behavior of white-tailed ptarmigan, dusky grouse, greater prairie-chickens, Columbian sharp-tailed grouse, and wild turkey. In retirement, he continues to work on projects involving white-tailed ptarmigan, greater sage-grouse, and Columbian sharp-tailed grouse.

Allan E. Thomas earned his B.Sc. Degree in wildlife management with minors in fisheries and range management from the University of Arizona. He also conducted graduate work at the same university and received additional credits from attending schools in Washington, South Dakota, Arkansas, Alaska, and Idaho. His work experience spans more than 50 years and includes positions primarily with the Bureau of Land Management (22 years) and U.S. Fish and Wildlife Service (19 years). He retired from the Bureau of Land Management in 1999 and started another career as a private consultant in Boise, Idaho.

Dedication

Sadly, Allan E. Thomas passed away before this assessment was completed. Allan was a devoted conservation biologist who believed strongly in documenting and communicating biological information. This assessment is testimony to Allan's work ethic and is dedicated to his memory.

Cover Photo Credit

Photograph of male Columbian sharp-tailed grouse in an alert posture by Richard W. Hoffman.

Summary of Key Components for Conservation of Columbian Sharp-tailed Grouse

Status

The Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*; CSTG) is one of six existing subspecies of sharp-tailed grouse in North America. It is endemic to big sagebrush (*Artemisia tridentata*), shrubsteppe, mountain shrub, and riparian shrub plant communities of western North America. The subspecies currently occupies less than 10 percent of its historic range, with only three metapopulations remaining in central British Columbia, southeastern Idaho and northern Utah, and northwestern Colorado and south-central Wyoming. Within Region 2 of the USDA Forest Service (USFS), this grouse formerly occurred in as many as 22 counties in western Colorado and in portions of 11 counties in west-central, southwestern, and south-central Wyoming. Today, viable populations occur in only three counties in Colorado and one county in Wyoming. Attempts are being made to reintroduce CSTG to previously occupied habitats in southwestern and north-central Colorado. Approximately 68 percent of the occupied habitat in Region 2 is on private lands, and only 4 percent is on lands administered by the USFS.

The CSTG has been petitioned twice for listing under the Endangered Species Act. Under both petitions, the finding was not warranted. USFS Region 2 and the state offices of the Bureau of Land Management in Colorado and Wyoming have designated the CSTG a sensitive species. Both the Wyoming Game and Fish Department and Colorado Division of Wildlife list it as a species of special concern.

Primary Threats

Threats to CSTG are widespread across its range in Region 2, occur at all spatial scales, and transcend local, state, and regional jurisdictions. Many of the threats are inter-related and synergistic in their impacts on CSTG. Even when the threats are not related, their impacts tend to be cumulative. The primary threats are all human-related. Foremost are habitat loss and degradation caused by conversion of native habitats to pasture and croplands, overgrazing by domestic livestock, energy development, use of herbicides to control big sagebrush, alteration of natural fire regimes, invasion of exotic plants, and urban and rural expansion.

Possible loss of Conservation Reserve Program (CRP) lands is the single most important immediate threat to CSTG in Region 2 and elsewhere throughout the subspecies' range. Currently, CRP lands support 21 percent of the known active leks in Region 2, and many CRP fields provide critical nesting and brood-rearing habitats for CSTG. Nearly 70 percent of all CRP contracts within the occupied range of CSTG in Region 2 are scheduled to expire by 2010, and there are strong indications that Congress will not include provisions in the 2007 Farm Bill for their renewal. What will become of these lands if the contracts are allowed to expire is uncertain, but it is likely that their value as habitat for CSTG will diminish.

Livestock grazing is the dominant use on public and private lands within the occupied range of CSTG in Region 2. While grazing levels have declined in Region 2, grazing continues to be an issue because lands subjected to past overgrazing have not been rested and given the opportunity to recover.

Until recently, oil and gas development was not considered a threat to CSTG in Region 2. However, with oil and gas prices reaching all-time highs and with strong support from the current political administration, oil and gas exploration and development have increased dramatically throughout the West. This activity has expanded into the core range of CSTG in Region 2. Impacts of oil and gas development include direct habitat loss and fragmentation from well, road, and pipeline construction; displacement (i.e., avoidance behavior) of individuals caused by excessive human activity; increased avian predation due to the construction of artificial perch sites; and increased mortality due to collisions with utility lines and vehicles. If oil and gas resources in Region 2 are developed to their fullest potential, the outcome could be devastating to CSTG populations.

The most essential component of habitats used by CSTG during winter in Region 2 is the presence of serviceberry (*Amelanchier* spp.). Serviceberry is the primary food source for CSTG from late fall through early spring. Any activity that reduces the distribution and abundance of serviceberry may have negative consequences to CSTG.

Primary Conservation Elements, Management Implications and Considerations

The keys to successful management of CSTG in Region 2 are protection and enhancement of existing habitats and restoration of habitats that are no longer occupied or are severely degraded. The natural processes that perpetuate the habitats upon which CSTG rely have been significantly disrupted by human activities and are no longer intact. Consequently, in most situations, some form of human intervention is necessary to correct the problems. This may be as simple as eliminating the activity causing the problem and allowing the plant community to recover on its own, or it may involve extensive restoration of the plant community. Protection and management of native cover types should receive top priority. There should be no net loss of sagebrush, shrubsteppe, or mountain shrub cover types in Region 2. Some of the same activities responsible for the loss and degradation of shrubsteppe and mountain shrub habitats also may be used to enhance and restore these habitats when properly applied. These activities include prescribed fire, grazing, use of herbicides, and mechanical treatments. Managers must be acutely aware that multiple factors affect CSTG populations, and they should consider the cumulative effects of these factors when formulating any future management actions.

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INTRODUCTION

This assessment is one of many being produced to support the Species Conservation Project for the USDA Forest Service (USFS) Rocky Mountain Region (Region 2). The Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*; CSTG) is the focus of an assessment because Region 2 lists it as a sensitive species, and conservation of sensitive species is to be integrated into National Forest System land management planning. The CSTG is classified as a sensitive species within Region 2 due to its restricted distribution and limited population size. The CSTG also is of special concern within Region 2 and throughout its range because it has been petitioned twice for federal listing under the Endangered Species Act. Only a single metapopulation exists within Region 2, and it is disjunct from the nearest other populations in Utah and Idaho. This alone is sufficient reason the subspecies requires special management attention.

This assessment addresses the biology and conservation of the CSTG throughout its historic and current ranges, focusing more specifically on Region 2 (**Figure 1**). The broad nature of the assessment leads to some constraints on the specificity of information for particular locales. Completing the assessment required the establishment of limits concerning the geographic scope of particular aspects of the assessment. This introduction defines the goal of the assessment, outlines its scope, describes the information used to produce the assessment, and discusses the process used in its production.

Goal

Species conservation assessments produced for the Species Conservation Project are designed to provide forest managers, research and management biologists, other agencies and organizations, and the public with a comprehensive discussion of the

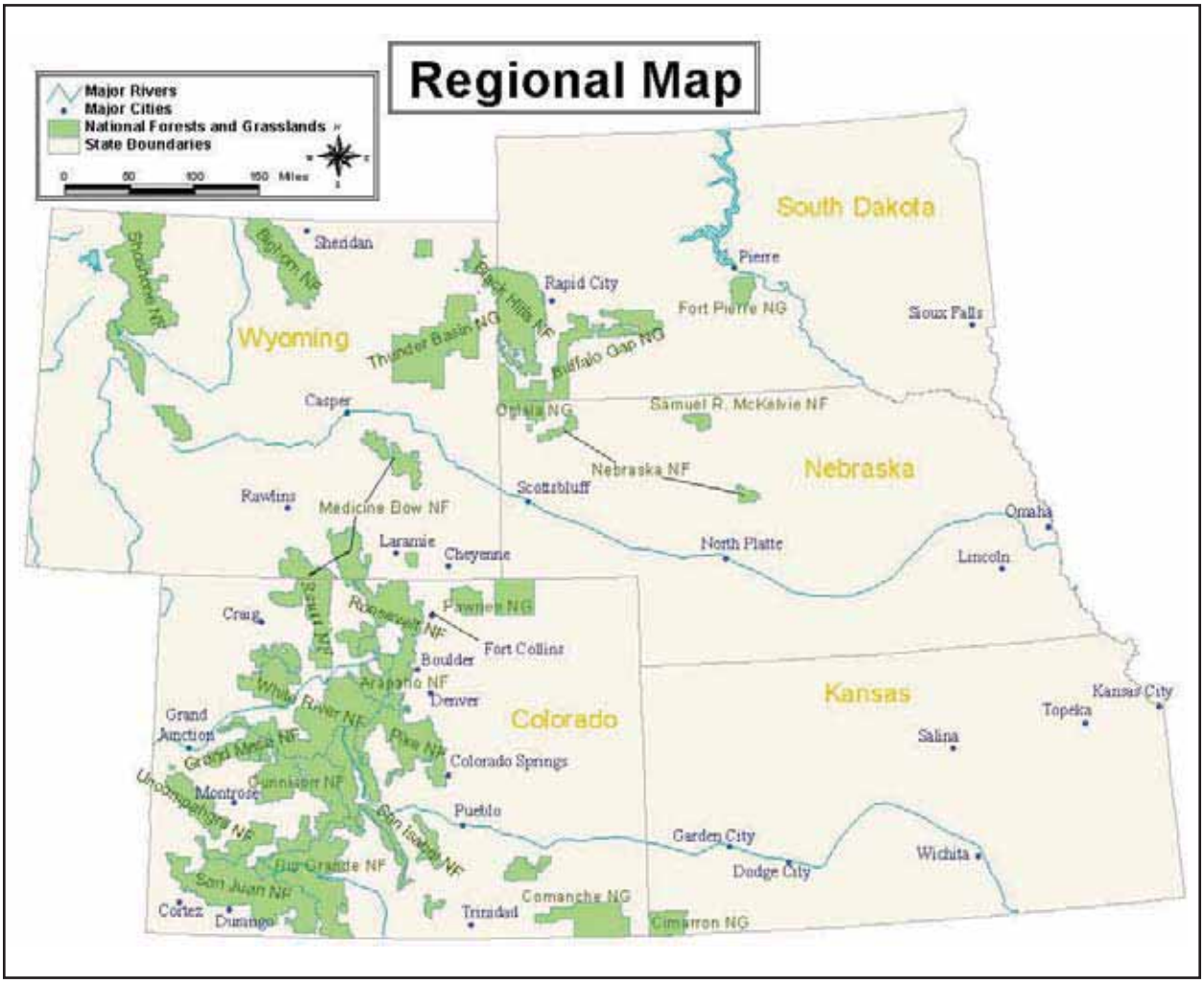

Figure 1. National forests and grasslands of USDA Forest Service Rocky Mountain Region.

biology, ecology, conservation status, and management requirements of selected species based on scientific knowledge accumulated prior to initiating the assessment. The assessment goals limit the scope of the work to critical summaries of scientific knowledge, discussion of broad implications of that knowledge, and outlines of information needs. The ultimate goal is to provide managers with an ecological framework upon which to formulate sound decisions. This assessment identifies threats to CSTG and implications if these threats are left unchecked. It cites previously published recommendations and examines the success or failure of recommendations that have been implemented. Additionally, the assessment provides management strategies not previously proposed elsewhere along with insight into the consequences of changes in the environment that result from management (i.e., management implications).

Scope

This assessment examines the biology, ecology, management, and conservation of CSTG with specific reference to the geographic and ecological characteristics of the USFS Region 2. Two subspecies of sharp-tailed grouse occur within Region 2. The focus of this assessment is on the Columbian subspecies. Some of the literature on this subspecies originates from field investigations and planning outside of Region 2. This document places that literature in the ecological and social context of Region 2. This assessment is concerned with the reproductive behavior, population dynamics, habitat relationships, and other characteristics of CSTG in context of the current environment rather than under historical conditions. The historical environment of the subspecies is considered in conducting the synthesis, but placed in context with the current environment.

Data Used to Produce This Assessment

In producing the assessment, information was gathered from peer-reviewed sources, theses, dissertations, agency and university technical reports, research reports, and data accumulated by resource management agencies. Non-refereed information was used where this information was deemed reliable and necessary to fill knowledge gaps. The nature of this information is clearly acknowledged and used with caution. Not all publications on CSTG are referenced in the assessment, nor are all published materials considered equally reliable. In reviewing the literature, it was discovered that several publications contained redundant information. Therefore, it was not necessary to cite all of them. The assessment emphasizes refereed literature because this is the accepted standard in science. However, even peer-reviewed literature has its strengths and weaknesses. If new information refutes previously published data, the discrepancies are noted. In addition, the strengths of particular ideas are evaluated, and alternative explanations are described when appropriate.

A concerted effort was made to collect, review, and evaluate all pertinent information (published and unpublished) on the management status, natural history, and conservation of CSTG. This included reviewing literature on other subspecies of sharp-tailed grouse and on other species of grouse and incorporating this information into the assessment where it was relevant to CSTG and Region 2. Users of this assessment should be aware that although there is a wealth of information on sharp-tailed grouse, there is a dearth of published literature on the Columbian subspecies. This is because early on, populations were severely reduced or extirpated in many states, thus, opportunities for study were limited. Storch (2000) places the number of scientific and semi-scientific publications on sharp-tailed grouse at slightly over 400. Of the 17 grouse species listed by Storch (2000), the sharp-tailed grouse ranks 6th in available publications. Probably less than 100 of the publications on sharp-tailed grouse pertain to the Columbian subspecies.

Plant names used in this assessment follow the USDA Plants Database available at http://www.plants.usda.gov.

Treatment of Uncertainty

Science represents a rigorous, systematic approach to obtaining knowledge. Competing ideas regarding how the world works are measured against observations. Since our descriptions of the world are incomplete and our observations are limited, science focuses on approaches for dealing with uncertainty. A commonly accepted approach to science is based on a progression of critical experiments to develop strong inference (Platt 1964). However, it is often difficult to conduct experiments that produce clean results. This is frequently true in the ecological sciences because of the number of variables that one must consider and control for. Consequently, we often must rely on observations, inferences, sound thinking, and models to guide our understanding of ecological relations. Such is the case for CSTG. Much of the published information on CSTG originates from descriptive rather than experimental studies. Even so, alternative approaches such as modeling, critical assessment of observations (i.e.,

descriptive studies), and inferences have contributed greatly to our understanding of the ecology of CSTG. This assessment describes accepted knowledge about the Columbian subspecies and identifies weaknesses in that knowledge. **Users of this assessment are strongly encouraged to read the document in its entirety. Otherwise, single statements may be taken out of context or misinterpreted.**

Publication of Assessment on the World Wide Web

To facilitate use of species assessments produced by the Species Conservation Project, they are published on the USFS Region 2 World Wide Web site at http://www.fs.us/r2/projects/scp/assessments/index.shtml. Placing the documents on the Web makes them available to potential users more rapidly than publishing them as reports, and it simplifies future revisions and inclusion of new information.

Peer Review

Assessments developed for the Species Conservation Project have been peer reviewed prior to release. This document was reviewed through a process administered by the Society for Conservation Biology. Two recognized experts provided critical review of the manuscript. Peer review was designed to improve the quality of communication and to increase the rigor of the assessment.

MANAGEMENT STATUS AND NATURAL HISTORY

Management Status

Taxonomists have long debated the validity of designating taxa below the species level (reviewed by Haig et al. 2006). Careless taxonomy and over-application of the subspecies concept for species that attract human interest have exacerbated the debate. However, this does not invalidate the concept of subspecies as a meaningful biological entity. Management of definable subspecies is essential for maintaining biological diversity and insuring evolutionary potential within the species (Haig et al. 2006). This is one reason why the U.S. Endangered Species Act allows for the listing of subspecies and other groupings below the species rank. Thus, although the CSTG is only one of six existing subspecies of sharp-tailed grouse, this does not diminish its importance in the conservation of the species. On the contrary, Miller and Graul (1980) identified the CSTG as the subspecies of sharp-tailed grouse most in need of conservation.

The U.S. Fish and Wildlife Service (USFWS) does not consider the CSTG to be a bird of conservation concern, despite being petitioned twice for listing (U.S. Department of Interior 2002). The Biodiversity Legal Foundation petitioned to list CSTG in 1995 as threatened in the lower conterminous United States pursuant to the Endangered Species Act (Carlton 1995). The USFWS did not act on the petition until October 1999, at which time the Service ruled the petition contained sufficient information to warrant a full assessment of the subspecies' status. On 11 October 2000, the USFWS issued its 12-month finding that the petition to list CSTG as a threatened subspecies throughout its historic range in the contiguous United States was not warranted (U.S. Department of Interior 2000). In making this finding, the USFWS retained the option to list CSTG should additional information become available to indicate such action was appropriate and warranted. The Service also retained the option of recognizing discrete populations for listing if information becomes available to warrant such action.

Forest Guardians filed the second petition to list the CSTG on 14 October 2004 (Banerjee 2004). After being sued, the USFWS subsequently acted on the petition. On 21 November 2006, the USFWS issued a 90-day finding that the petition did not provide sufficient information to indicate that listing CSTG was warranted, and therefore, the Service would not initiate a status review in response to the petition (U.S. Department of Interior 2006).

The Natural Heritage Program (http://www.natureserve.org/explorer, accessed 12 August 2006) has given CSTG a global rank of G4T3, indicating as a species the sharp-tailed grouse is secure throughout its range, but the Columbian subspecies is vulnerable to extirpation or extinction. National rankings are N3 (vulnerable to extirpation or extinction) for the United States and N2N3 (imperiled to vulnerable) in Canada. State and Provincial rankings are as follows: British Columbia (S2S3: imperiled to vulnerable), California (SX: extinct), Colorado (S2: imperiled), Idaho (S3: vulnerable), Montana (S1: critically imperiled), Nevada (S1?: critically imperiled, pending success of reintroduction program), Oregon (S1: critically imperiled), and Wyoming (S1: critically imperiled). Heritage Programs in Washington and Utah do not provide specific rankings for CSTG because they only track at the species level. However, since the CSTG is

the only subspecies of sharp-tailed grouse in Washington and Utah, the species level rankings (Washington: S2 imperiled; Utah S1S2 critically imperiled to imperiled) are in essence for the CSTG.

In 1993, the British Columbia Ministry of Environment, Lands and Parks Wildlife Branch blue listed the CSTG (Ritcey 1995). In 1998, the Washington Department of Fish and Wildlife classified CSTG as threatened (Hays et al. 1998). Most other states where the CSTG still occurs, including Colorado, Wyoming, Idaho, Montana (recently extirpated), and Utah, identify it as a bird of special concern. It is on the Watch List of birds in Nevada and is not classified in Oregon and California. Columbian sharp-tailed grouse are legally hunted in British Columbia, Colorado, Idaho, and Utah.

USFS Region 2 has designated the CSTG as a sensitive species. It also is on the sensitive species list for Regions 3 (Southwest), 4 (Intermountain), and 6 (Pacific Northwest), but it will soon be removed from the list for Region 3 because it no longer occurs there. Although the CSTG occurs in Region 1 (Northern), it is not found on USFS lands there and, therefore, is not listed as a sensitive species by the USFS in this Region.

The Bureau of Land Management (BLM) designates sensitive species by states rather than Regions. The BLM classifies the CSTG as a sensitive species in every state where it occurs on BLM lands. Only two states (Colorado and Wyoming) within Region 2 of the USFS support CSTG. In both states, the BLM lists the CSTG as a sensitive species.

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

Within Region 2, state and federal agencies have limited regulatory authority to protect habitats of CSTG because only about 32 percent of the occupied range occurs on public lands. The USFS administers approximately 4 percent of the occupied habitat of the CSTG in Region 2 (**Table 1**). Addressing the problems associated with the conservation of CSTG depends upon the involvement and cooperation between federal and state agencies, and private landowners.

USFS Region 2 includes the CSTG on the Regional Forester's sensitive species list, and by policy (U.S. Department of Agriculture 2003) Region 2 must actively manage for CSTG to avoid trends towards federal listing and to maintain viability. The Region must develop and implement conservation strategies for sensitive species and their habitats in coordination with other USFS units, other state and federal agencies, and private landowners. This may include collaboratively developing individual or multi-species conservation strategies, formalizing interagency conservation agreements, and incorporating recommendations into management direction set forth in Land and Resource Management Plans. The Region also must prepare Biological Evaluations on the potential effects to sensitive species of any proposed actions on lands under their administration. The USFS must integrate scientific information from regional species evaluations, species and ecosystem assessments, and conservation strategies into their planning and implementation process. Appropriate inventories and monitoring of sensitive species must be conducted in coordination with other agencies and partners to improve knowledge of the species' distribution, status, and responses to management activities.

State and Canadian Provincial wildlife agencies have complete management responsibilities for CSTG because it is not federally listed or covered by any acts or treaties, such as the Migratory Bird Treaty Act, that may supersede the authority of the state or province. These agencies develop regulations, set hunting seasons, and monitor harvest. In Region 2, Colorado and Wyoming classify the CSTG as a game species, but due to its restricted distribution and small population size, the CSTG is not legally hunted in Wyoming.

Table 1. Approximate distribution of land ownership (km^2) within the occupied range of Columbian sharp-tailed grouse in USDA Forest Service Rocky Mountain Region.

Land status	Colorado (%)	Wyoming (%)	Region 2 (%)
Public	1,543 (25)	970 (61)	2,513 (32)
USDA Forest Service	206 (3)	92 (6)	298 (4)
Private	4,730 (75)	618 (39)	5,348 (68)
Totals	6,273	1,588	7,861

Columbian sharp-tailed grouse are hunted in Colorado. Areas open to hunting are restricted to nine small game hunting units in portions of Moffat, Routt, and Rio Blanco counties in northwestern Colorado. This represents approximately 70 percent of the known occupied range of CSTG in Colorado, excluding areas where CSTG have recently been transplanted. Season length varies from 16 to 22 days, opening on 1 September and closing following the third weekend in September. Bag and possession limits for CSTG were in aggregate with sage-grouse (*Centrocercus* spp.) until 1981. From 1981 to 1991, bag and possession limits were three and six sharp-tailed grouse, respectively. From 1992 to 1994, the possession limit was increased to nine sharp-tailed grouse, and the bag limit remained at three sharp-tailed grouse per day. The bag and possession limits were reduced in 1995 to two and four, respectively, and currently remain at these levels.

Until 1995, harvest estimates in Colorado were obtained using a post-season mail survey of a sample (3 to 5 percent) of small game license buyers. Hunters were required to obtain a special permit (free and unlimited in number) from 1995 to 1997 to hunt sharp-tailed grouse. The purpose of the permit system was to gather more precise harvest information than could be obtained from the mail survey of small game license holders. Both a post-season mail survey (5 percent of small game license holders) and a telephone survey (100 percent of permit holders) were conducted each year during 1995, 1996, and 1997. Currently, harvest estimates for Colorado are calculated using telephone surveys based on information obtained from the Harvest Information Program (HIP, available at http://www.colohip.com). This is a joint program between the Colorado Division of Wildlife (CDOW) and USFWS, designed to improve migratory bird and small game harvest estimates. Any small game license holder who intends to hunt must validate their license by calling the HIP phone number or registering online. At this time, they are asked a series of questions. The questioning eventually identifies those hunters who will not hunt, are somewhat likely to hunt, or are very likely to hunt CSTG. Samples for the telephone survey are then selected as: 50 percent of those very likely to hunt CSTG, 20 percent of those somewhat likely to hunt, and 10 percent of those who will not hunt.

Braun et al. (1994) considered mail surveys inadequate for estimating harvest of upland game birds because such surveys cannot be conducted in a timely fashion, response rates are low, and harvest estimates tend to be inflated due to non-response biases (successful hunters are more likely to return questionnaires). This particularly applies to lesser-hunted species, such as CSTG. A comparison of mail and telephone survey results supports this conclusion. Mail surveys grossly over-estimated the harvest six to 10-fold compared to telephone surveys (**Table 2**).

Outside of Region 2, management and conservation plans, and status assessments have been prepared for CSTG in British Columbia (Ritcey 1995), Idaho (Ulliman et al. 1998), Montana (Wood 1991), Utah (Utah Division of Wildlife Resources 2002), and Washington (Tirhi 1995). Within Region 2, a plan has been developed for northwestern Colorado (Hoffman 2001) but not south-central Wyoming. However, many of the issues and strategies related to CSTG in northwestern Colorado (Hoffman 2001) also apply to south-central Wyoming, as populations in the two areas are contiguous. At the national level, Bart (2000) prepared a range-wide conservation assessment of the CSTG for the USFWS status review team. Ulliman (1995a) also authored a range-wide conservation assessment for the CSTG and its habitats, but this document has not been approved and made public. Internationally, the worldwide conservation action plan for grouse prepared by the International Union for the Conservation of Nature and Natural Resources addresses the CSTG (Storch 2000). This document is presently in the process of being revised and updated.

In 1990, the National Fish and Wildlife Foundation brought together federal, state, and local government agencies, private foundations, conservation organizations, industry, everyday citizens, and the academic community to form Partners in Flight (PIF). This is a voluntary, international coalition dedicated to "keeping common birds common" and "reversing the downward trends in declining species." At the national level, the PIF North American Land Bird Conservation Plan recognizes the sharp-tailed grouse as an Additional Stewardship Species and has assigned it a vulnerability assessment score of 11 of a maximum of 20 (Rich et al. 2004). This plan focuses at the species level and does not recognize or rank individual subspecies. The real foundation of the PIF program is the development of land bird conservation plans for each state or physiographic region. These plans identify priority species and habitats and establish objectives for conserving, managing, and monitoring bird populations and their habitats. Plans have been developed for Colorado (Beidleman 2000) and Wyoming (Nicholoff 2003), the only two states within Region 2 where CSTG occur. Both plans have identified habitats (mountain shrublands and sagebrush shrublands) used by CSTG as priority cover types for conservation. However, only the

Table 2. Columbian sharp-tailed grouse season structure and harvest information for Colorado, 1990-2006.

Year	Season length (days)	Bag/possession limit	Number of hunters[1]	Total harvest[1]
1990	30	3/6	1,618	4,639
1991	30	3/6	1,686	2,550
1992	34	3/6	1,267	2,597
1993	33	3/6	1,157	1,761
1994	32	3/6	871	1,404
1995	17	2/4	128 (708)	111 (1,096)
1996	22	2/4	255 (900)	227 (1,327)
1997	21	2/4	97 (866)	102 (682)
1998	20	2/4	317	433
1999	19	2/4	304	328
2000	18	2/4	249	328
2001	22	2/4	236	393
2002	21	2/4	85	148
2003	20	2/4	166	336
2004	19	2/4	350	1,096
2005	18	2/4	576	679
2006	17	2/4	173	232

[1]Estimates based on mail surveys from 1990 to 1994, phone and mail surveys (in parentheses) from 1995 to 1997, and phone surveys only from 1998 to 2006.

Wyoming plan identifies CSTG as a priority bird species. The Colorado Land Bird Conservation Plan lists plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi*) but not CSTG as a priority species. Future revisions of this plan should consider including CSTG as a priority species in the mountain and sagebrush shrubland types within the Southern Rocky Mountain and Colorado Plateau Physiographic Regions.

Columbian sharp-tailed grouse are one of 15 upland game birds featured in the Colorado Division of Wildlife's Upland Bird Management Analysis Guide (Braun et al. 1994). The Guide identifies and discusses 15 issues that transcend all species of upland game birds (not all issues apply to CSTG), and further identifies issues specific to each species/subspecies addressed in the Guide. Three management issues specific to CSTG include:

1. Some suitable historic habitats remain unoccupied.

2. The harvest of CSTG in some areas may be excessive.

3. There is insufficient knowledge to manage habitats effectively to benefit CSTG.

Since the Guide was completed, the CDOW has implemented more conservative hunting regulations, developed a conservation plan (Hoffman 2001), initiated several studies to learn more about the habitat use patterns of CSTG (Boisvert 2002, Lassige 2002, Collins 2004), and conducted transplants of CSTG into historically occupied habitats in southwestern and north-central Colorado.

Throughout much of its present range, the CSTG occurs in close association with greater sage-grouse (*Centrocercus urophaisanus*) during the breeding, nesting, and brood-rearing periods (Apa 1998). Historically, CSTG also coexisted with Gunnison sage-grouse (*C. minimus*) and recently were reintroduced into previously occupied habitats in southwestern Colorado where Gunnison sage-grouse still occur. Greater and Gunnison sage-grouse have been petitioned for protection under the Endangered Species Act in eight petitions (reviewed by Connelly et al. 2004). This has prompted the development of a plethora of local, state, and national plans for sage-grouse and their habitats (reviewed by Connelly et al. 2004 and Gunnison Sage-grouse Rangewide Steering Committee 2005). These plans contain conservation strategies for managing sage-grouse populations and their habitats. Hoffman (2001) recommended that

where CSTG and sage-grouse coexist, plans for managing sage-grouse habitats should take precedence. This recommendation was based on the contention that managing for sage-grouse will benefit or at the very least not harm CSTG populations.

Biology and Ecology

Systematics and general species description

Columbian sharp-tailed grouse belong to the order Galliformes, Family Phasianidae, and subfamily Tetraoninae. Sharp-tailed grouse have occupied western and northern North America since late Pleistocene. Fossil records of two extinct species of sharp-tailed grouse (*Pedioecetes lucasi* and *P. nanus*) have been reported from Pleistocene deposits at Fossil Lake, Oregon (Wetmore 1959). The sharp-tailed grouse was originally described in 1758 as *Tetrao phasianellus* by Linnaeus and subsequently placed in the monotypic genus *Pedioecetes* by Baird in 1858. The sharp-tailed grouse maintained its monotypic status until 1982 when it was classified as congeneric with prairie-chickens and moved to the genus *Tympanuchus* (American Ornithologists' Union 1983).

There are six existing and one extinct subspecies of sharp-tailed grouse in North America, including three southern and four northern forms:

Southern Forms:
T. p. columbianus – Columbian sharp-tailed grouse
T. p. jamesi – Plains sharp-tailed grouse
T. p. hueyi – New Mexico sharp-tailed grouse (extinct)

Northern Forms:
T. p. caurus – Alaskan sharp-tailed grouse
T. p. kennicotti – Northwestern sharp-tailed grouse
T. p. phasianellus – Northern sharp-tailed grouse
T. p. campestris – Prairie sharp-tailed grouse

The Columbian subspecies was first discovered by Lewis and Clark in 1805 and originally named by Ord in 1815 (Bent 1963). Lewis and Clark encountered the birds on the shrubsteppe plains of the Columbia River Basin, hence the name "Columbian" sharp-tailed grouse. The species name *phasianellus* is derived from the Greek word *phasianous* meaning little pheasant (Terres 1980). Vernacular names for the sharp-tailed grouse include brush grouse, spike-tail, pintail, spring-tail, speckle-belly, prairie pheasant, white-belly, and white-breasted grouse (Johnsgard 1973).

Ellsworth et al. (1995) reported that the genetic differentiation between sharp-tailed grouse and prairie-chickens is among the lowest in closely related species of birds. Hybridization between sharp-tailed grouse and greater prairie-chickens (*Tympanuchus cupido*) is common where the ranges overlap, with F_1 hybrids and backcrosses being fertile (Sparling 1980). The range of the Columbian subspecies does not overlap with the range of greater or lesser (*T. pallidicinctus*) prairie-chickens, but it does overlap with the range of dusky grouse (*Dendragapus obscurus*), greater sage-grouse, and Gunnison sage-grouse. Dusky grouse have been observed on CSTG leks in northwestern Colorado (R.W. Hoffman personal observation). Only one documented case of a sharp-tailed grouse x blue (dusky) grouse hybrid is recorded in the literature (Brooks 1907). Several cases of hybridization between greater sage-grouse and sharp-tailed grouse have been reported (Eng 1971, Kohn and Kobriger 1986, Aldridge et al. 2001). None of these accounts involved the Columbian subspecies. In spring 2002, three Columbian sharp-tailed grouse x greater sage-grouse hybrids were observed on a sage-grouse lek in northwestern Colorado (R.W. Hoffman personal observation). One specimen was collected and is in the Denver Museum of Nature and Science (Accession number 2002-33, R.W. Hoffman, Colorado Division of Wildlife, unpublished data).

Among the 12 species of grouse in North America, the sharp-tailed grouse ranks 7th in size. It is the most sexually monomorphic of the lek breeding Tetraoninae in both plumage and body size. Adults measure 41 to 47 cm in length. Distinguishing features include a rounded body with short legs; short, pointed (wedge-shaped) tail with elongated central rectrices (tail feathers); white spots on the primary wing feathers; and V-shaped markings on the breast (Tirhi 1995, Connelly et al. 1998). Both males and females produce a characteristic clucking sound when taking flight and fly in a straight or curvilinear pattern with alternating rapid wing beats followed by periods of gliding.

Overall, sharp-tailed grouse have a mottled brown, cryptic coloration. The head, back, and wings are heavily barred with dark brown, blackish, and buff coloration. Breast-feathers are white, with tawny drab margins, and the upper belly-feathers are white, with small dark olive brown subterminal V-shaped marks that fade towards the abdomen; undertail-coverts are white.

The white under-parts are conspicuous in flight. Nostrils and legs are feathered, and the toes have pectinations on the sides for walking on snow. Each gender has crescent-shaped, yellowish orange combs over the eyes. The combs are more prominent in males during the breeding season. Crown feathers are elongated and form a crest when erected.

The CSTG is the smallest subspecies of sharp-tailed grouse and tends to have a grayer plumage, more pronounced spotting on the throat, and narrower markings on the undersides (Johnsgard 1973). Fully-grown CSTG weigh on average between 640 and 800 g depending on gender, age, season of year, and geographic area. Males (average = 700 to 800 g during spring) weigh more than females do (average = 640 to 720 g during spring) (Meints 1991, Giesen 1992, Apa 1998, Boisvert 2002, Collins 2004), and within gender, adults weigh more than subadults do. Males and females appear similar in size, shape, and coloration unless the males are displaying and exposing the violet-colored air sacs on each side of the neck. The most reliable way to distinguish gender is from close examination of the crown feathers and two central tail feathers. Females have alternating brown and buff colored crosswise barring on the crown feathers, whereas the crown feathers of males are darker brown with buffy edges and lack barring (Henderson et al. 1967). The two central tail feathers are linearly barred in females and longitudinally barred in males (Henderson et al. 1967).

Sharp-tailed grouse can be separated into adults and subadults (yearlings) during most of the year based on shape and wear of the two distal primary feathers (Ammann 1944, Giesen 1999). During late summer and early fall, experienced observers can identify three age classes: adults (≥ 2 years), subadults (approximately 14 to 15 months), and juveniles (approximately 3 to 4 months). Once yearlings replace their two distal primaries, usually in early to mid-September, they cannot be distinguished from adults. Presence of juvenal secondaries and tertials are additional characteristics that can be used to separate juveniles from adults and subadults (Giesen 1999). Age classification of sharp-tailed grouse can be difficult at certain times of the year because differences between age classes can be subtle.

Distribution and abundance

Historically, sharp-tailed grouse inhabited 21 states, six Canadian provinces, and two Canadian territories (Aldrich 1963, Miller and Graul 1980, Connelly et al. 1998). The species currently occurs throughout much of its historical range in Canada, except southern British Columbia (Ritcey 1995, Connelly et al. 1998). In contrast, the range within the United States has declined dramatically. The species has been extirpated from California (Starkey and Schnoes 1976), Illinois (Miller and Graul 1980), Iowa (Grant 1963), Kansas (Miller and Graul 1980), Nevada (Wick 1955), New Mexico (Dickerman and Hubbard 1994), Oklahoma (Sutton 1974), and Oregon (Olsen 1976). In many states where the species still occurs, the occupied range has declined to a fraction of the historical range (Miller and Graul 1980).

The Columbian subspecies formerly occurred across approximately 867,000 km^2 of suitable habitat in the western United States (780,000 km^2) and Canada (87,000 km^2) in portions of British Columbia, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming (**Figure 2**; Aldrich 1963, Miller and Graul 1980, Bart 2000). The CSTG has the dubious distinction of being considered the most well known and abundant upland game bird in the Pacific Northwest (Bendire 1892), and one of the most striking examples of the reduction in game bird populations in the western United States (Marshall and Jensen 1937). Of the six existing subspecies of sharp-tailed grouse, the Columbian subspecies has experienced the greatest decline in distribution and abundance (Hamerstrom and Hamerstrom 1961, Miller and Graul 1980). The entire United States breeding population has been estimated at 51,000 to 52,000 grouse based on the best available data provided by the individual states to the USFWS in response to the petition to list the CSTG (U.S. Department of Interior 2000). The breeding population range-wide has been estimated at 56,000 to 61,500 grouse. Within the United States, the current occupied range encompasses approximately 38,400 km^2 (U.S. Department of Interior 2000). This represents an alarming 95 percent reduction in overall range from historic levels.

Over 95 percent of the breeding population occurs within three metapopulations: northwestern Colorado and south-central Wyoming, southeastern Idaho and northern Utah, and south-central British Columbia. Idaho supports about 55 percent of the remaining population, followed by British Columbia, Utah, and Colorado. Only remnant populations (<1,000 breeding birds) remain in Washington and Wyoming. The subspecies is believed to have disappeared from Montana within the past five years (R.D. Northrup personal communication 2005), and has long (>50 years) been extirpated from California (Starkey and Schnoes 1976), Nevada (Wick 1955), and Oregon (Olsen 1976).

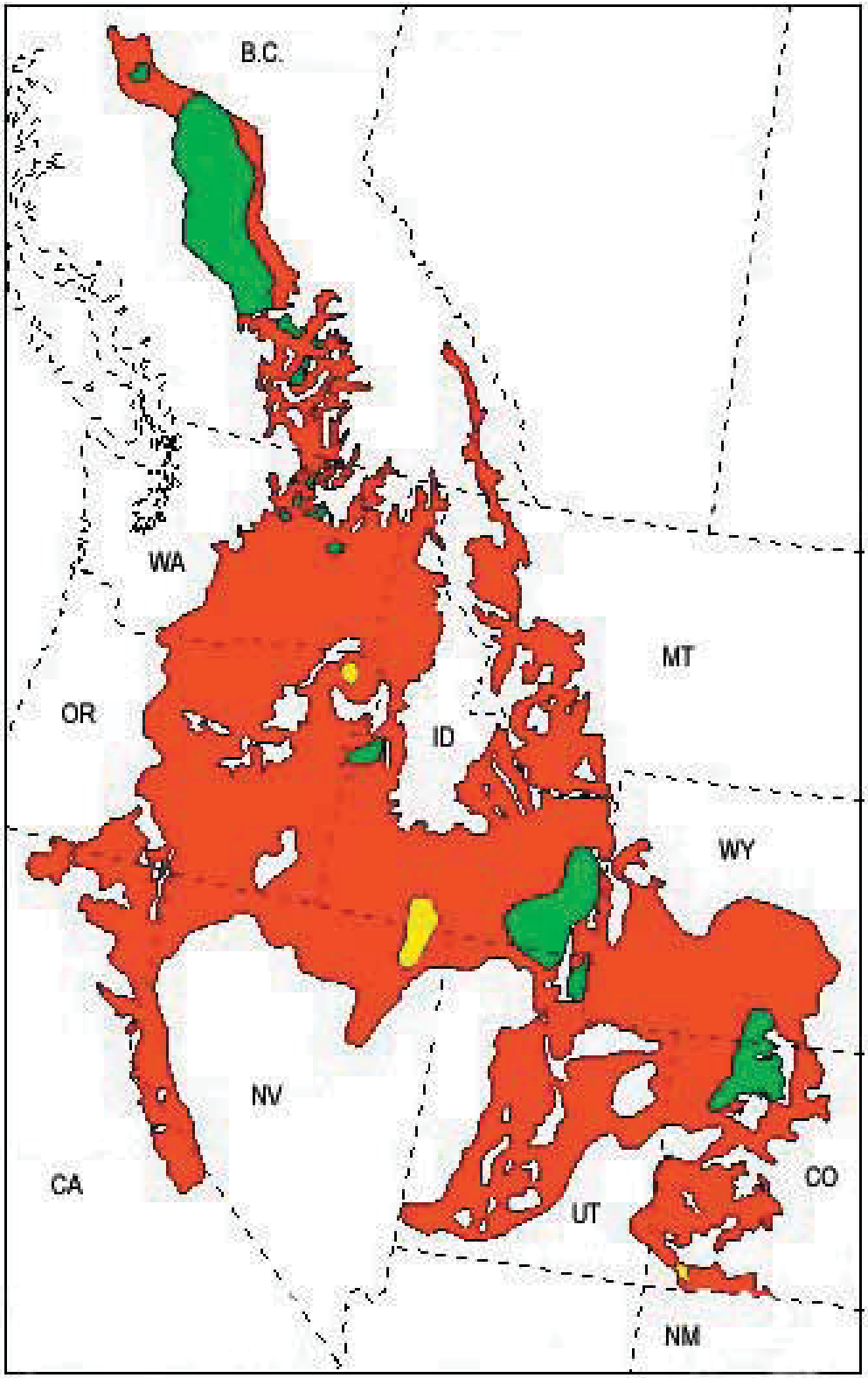

Figure 2. Historic (red) and current ranges (green = natural populations, yellow = reintroduced populations) of Columbian sharp-tailed grouse in western North America.

Attempts have been made to reintroduce CSTG into formerly occupied ranges in Idaho (Gardner 1997), Montana (Cope 1992), Nevada (Coates 2001), and Oregon (Crawford and Snyder 1995, Snyder et al. 1999, Crawford and Coggins 2000) and to supplement existing populations in Washington (Schroeder and Peterson 1998). The releases in Montana were unsuccessful. The probability of long-term success for releases in Nevada and Idaho appears high. The success of the releases in Oregon remains uncertain. Columbian sharp-tailed grouse still persist in Oregon, but the population is critically small (<50 grouse) and has not increased in abundance or distribution. Plans are to release more birds in Oregon to supplement the existing population (D.A. Budeau personal communication 2006). Supplemental releases in Washington were conducted in an effort to maintain a small population on the Scotch Creek Wildlife Area until habitat improvement projects could be completed. The supplemental releases appeared to work as lek counts increased the following spring. Additional supplemental releases were conducted in Washington in 2005 and 2006 on the Swanson Lakes Wildlife Area and Colville Indian Reservation (M.A. Schroeder personal communication 2005).

Within Region 2, CSTG only occur in Colorado and Wyoming (**Figure 3**). Plains sharp-tailed grouse occur in Region 2 in Colorado, Wyoming, Nebraska, and South Dakota. Ranges of the two subspecies in Wyoming are less than 225 km apart. Historically, the two subspecies may have occupied habitats in central Wyoming within 100 km of each other. Lack of information, unreliable information, poor record keeping, and frequent misidentification of dusky grouse and sage-grouse for sharp-tailed grouse have made it difficult to track the status and distribution of this grouse in Colorado and Wyoming. The distribution is more clearly documented in Colorado (Rogers 1969, Giesen and Braun 1993, Hoffman 2001) than in Wyoming (Oakleaf et al. 1982).

Private lands comprise 68 percent of the occupied range in Region 2. Four percent (Colorado = 3 percent, Wyoming = 6 percent) of the occupied range of CSTG in Region 2 occurs on lands administered by the USFS in portions of the Routt, Medicine Bow, and White River national forests (**Table 1**, **Figure 3**). The historical range in Region 2 also included portions of the San Juan, Grand Mesa-Uncompahgre-Gunnison, and possibly the Rio Grande, Arapaho-Roosevelt, and Shoshone national forests. Within Wyoming, the historical range extended into the Bridger-Teton National Forest, which is part of Region 4.

Scattered populations of CSTG likely occurred throughout suitable habitats in northwestern, west-central, southwestern, and south-central Wyoming. Fuller and Bole (1930) reported observing sharp-tailed grouse near Pinedale, Wyoming, and Sharritt (1946) mentions the presence of sharp-tailed grouse on the National Elk Refuge near Jackson. Columbian sharp-tailed grouse are currently present or were historically present within all the counties in Utah and Idaho that border western Wyoming (Bart 2000, Utah Division of Wildlife Resources 2002). There is no reason to believe these populations did not extend into western Wyoming. Based on available information, it is likely CSTG historically occurred in Teton, Lincoln, Uinta, Park, Hot Springs, Fremont, Sublette, and Carbon counties, and possibly in Natrona, Washakie, and Big Horn counties, Wyoming.

Presently, the only known breeding population of CSTG in Wyoming is restricted to the south-central part of the state in Carbon County within and immediately west and north of the Medicine Bow National Forest (Bart 2000). This population is an extension of a larger population in northwestern Colorado (Hoffman 2001). The total occupied range in Wyoming encompasses about 1,588 km^2, of which 61 percent is publicly owned and 39 percent is privately owned. The USFS, BLM, and State of Wyoming (primarily State Trust Lands) respectively administer 6, 39, and 16 percent of the occupied range of CSTG in Wyoming.

Twenty-eight lek sites have been identified in south-central Wyoming. The highest count occurred in 2005 when 458 grouse were counted on 13 leks (**Table 3**). Bart (2000) conservatively estimated the Wyoming population at 500 grouse, and suggested that the actual population is probably much larger. Intensive surveys to locate new leks have not been conducted in Wyoming, but local wildlife agency personnel are confident more leks are present in south-central Wyoming than located to date (T.P. Woolley personal communication 2005).

Bailey and Niedrach (1965), citing numerous other sources (Morrison 1888, Gilman 1907, Cary 1909, Cooke 1909, Marsh 1931), provide direct and indirect evidence of CSTG inhabiting portions of western Colorado from La Plata County north to Moffat and Routt counties. Rogers (1969) reported that by the early 1960's, CSTG only occurred in eight counties in Colorado: Dolores, Gunnison, Mesa, Moffat, Montezuma, Montrose, Rio Blanco, and Routt. By the early 1990's, the distribution of CSTG in Colorado was restricted to Routt, Moffat, Rio Blanco, and Mesa counties (Giesen and Braun 1993).

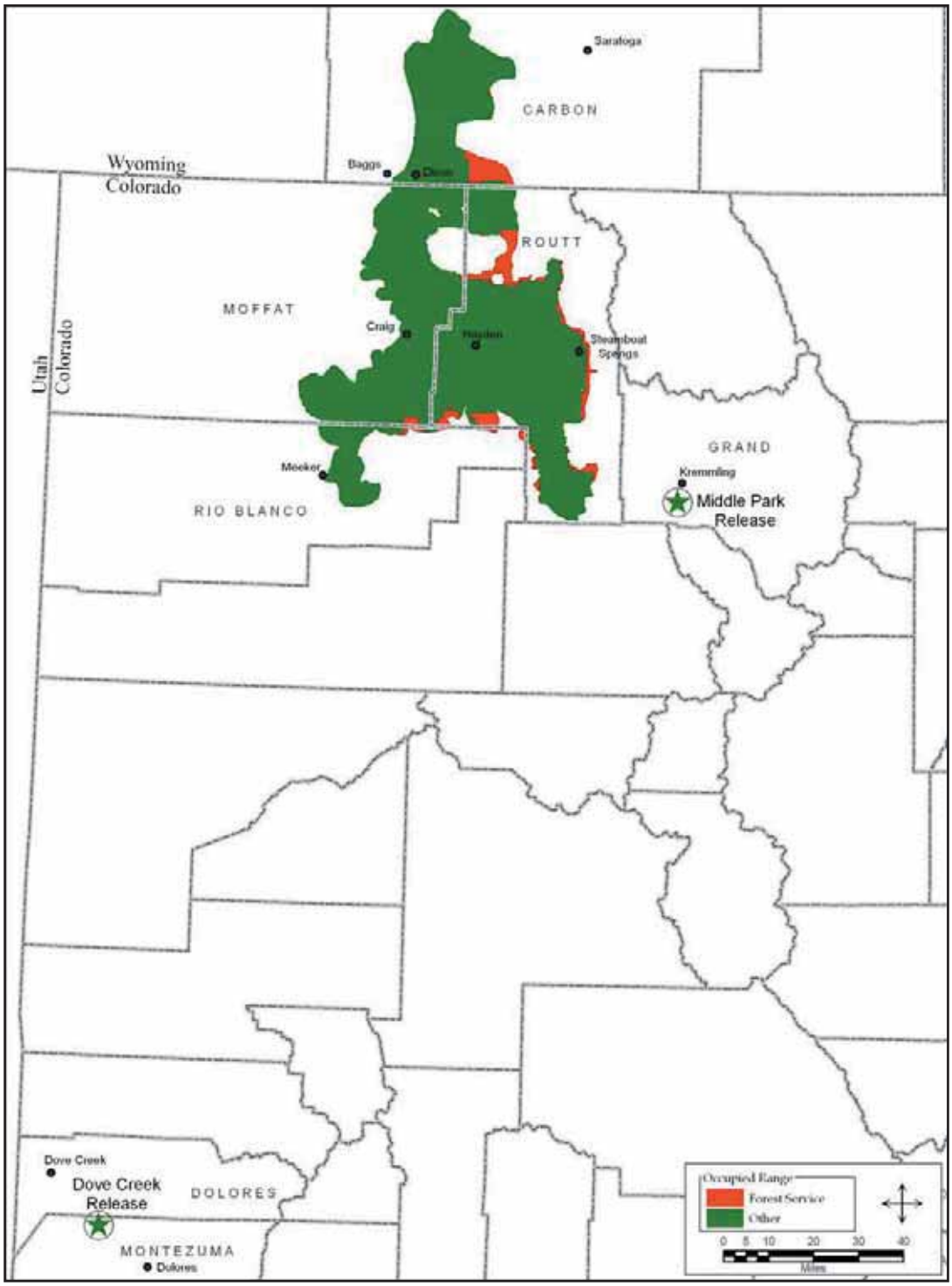

Figure 3. Distribution of Columbian sharp-tailed grouse within the Rocky Mountain Region of the USDA Forest Service.

Table 3. Total number of Columbian sharp-tailed grouse counted on leks in south-central Wyoming, 1999-2006.

	1999	2000	2001	2002	2003	2004	2005	2006
Total leks counted	9	15	9	10	11	12	13	13
Total grouse counted	114	196	134	220	327	368	458	362

The exact historical range of CSTG in Colorado is poorly documented. Rogers (1969) and Giesen and Braun (1993) suggested CSTG may have inhabited as many as 22 counties in western Colorado. However, this distribution may be exaggerated. Specimens and/or documented lek sites of CSTG are only available from Summit, Grand, Pitkin, Moffat, Montrose, Delta, Rio Blanco, and Routt counties. Valid sightings are reported from Montezuma, Dolores, La Plata, Garfield, Gunnison, San Miguel, Ouray, Jackson, and Eagle counties. There are questionable or unconfirmed records of CSTG from Archuleta, Saguache, Mineral, and Hinsdale counties. Bailey and Niedrach (1965) mention the existence of 20 skins collected from Moffat, Routt, Pitkin, and Grand counties. Giesen and Braun (1993) reported examining 13 specimens of CSTG from Moffat, Routt, Grand, and Summit counties in the Denver Museum of Natural History. They did not find specimens from Pitkin County as reported by Bailey and Niedrach (1965).

Columbian sharp-tailed grouse are currently known to occur in Moffat, Routt, and Rio Blanco counties, Colorado. This population is contiguous with the population in south-central Wyoming in Carbon County. In addition, in fall 2004, spring 2005, spring 2006, and spring 2007, CSTG were reintroduced into formerly occupied habitats in southwestern Colorado in Montezuma County near the boundary with Dolores County. In addition, in fall 2006 and spring 2007, two of four scheduled transplants were made to Middle Park in Grand County. At least 5 years of monitoring will be necessary before any conclusions can be made about the success or failure of CSTG to establish a self-sustaining population in Dolores, Montezuma, or Grand counties. The last confirmed sightings of CSTG on leks from anywhere else in the state are from Mesa County in 1985 (Giesen 1985). Efforts to locate CSTG in Mesa County in the early 1990's were unsuccessful (R.W. Hoffman unpublished data). Biologists observed two sharp-tailed grouse on the Radium State Wildlife Area in Grand County while flying deer surveys in January 2004 (A.A. Holland personal communication 2006). However, no leks have been documented in this area.

The total occupied range of CSTG in Colorado is 6,273 km^2. This estimate only pertains to the occupied range within Moffat, Routt, and Rio Blanco counties. Bart (2000) estimated the occupied range in Colorado as 10,350 km^2. This estimate includes portions of Mesa County where sharp-tailed grouse are believed to no longer occur. In contrast to Wyoming, most (75 percent) of the occupied range in Colorado is privately owned. The USFS and BLM administer 3 and 13 percent of the occupied range, respectively, and the State of Colorado administers 9 percent primarily in the form of State Trust Lands (6 percent). Most State Trust Lands in Moffat, Routt, and Rio Blanco counties are leased for surface use (i.e., grazing and crop production) and mineral extraction, and the lessee controls the access. Although State Trust Lands are publicly owned, in essence, they are managed and treated as privately owned. The public only has seasonal access to certain parcels of State Trust Lands that are leased by the CDOW for hunting and fishing privileges.

Intensive lek surveys conducted in northwestern Colorado since 1997 have resulted in the location of 250 lek sites in Routt (184; 74 percent), Moffat (65; 26 percent), and Rio Blanco (1; <1 percent) counties, of which a minimum of 192 (77 percent) have been active at least two of the past three years (**Table 4**). Nearly 89 percent of the known lek sites are on private lands. Only four (14 percent) of the 28 leks on public lands occur on lands administered by the USFS. Most (17; 61 percent) of the leks on public lands are on State Trust Lands. The remaining seven leks are on lands administered by the BLM (four) and Colorado State Parks (three leks). The average number of males counted on leks over the past 10 years (1997–2006) has fluctuated from 11.9 to 19.3 and has averaged 16.5 (**Table 4**).

Table 4. Columbian sharp-tailed grouse lek counts and lek surveys, northwestern Colorado, 1997-2006.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Known leks	75	114	141	156	174	185	202	218	238	250
New leks located	39	27	15	18	11	17	16	20	12	12
Total leks	114	141	156	174	185	202	218	238	250	262
Leks counted	91	125	146	165	168	184	193	210	218	236
Active leks	77	94	114	133	136	143	165	175	182	203
Active leks counted	44	86	103	127	136	143	165	174	176	201
Total males counted	524	1107	1646	2454	2376	2271	2385	3317	3040	3216
Males/active lek	11.9	12.9	16.0	19.3	17.5	15.9	14.5	19.1	17.3	16.0

Hoffman (2001) estimated the minimum spring breeding population of CSTG in northwestern Colorado at 6,080 birds. At the time, Hoffman (2001) estimated that about 70 percent of the suitable habitat had been searched. Assuming the unsearched habitat supported proportionally the same number of active leks as the areas already searched, Hoffman (2001) calculated there were about 190 active leks in northwestern Colorado. Assuming a 1:1 sex ratio and an average of 16 males per lek, the breeding population was estimated as 16 males per lek X 190 leks X 2 (accounts for females) = 6,080. More recent surveys indicate that the number of active leks is greater than 190. As of spring 2006, 203 active leks have been documented in northwestern Colorado. The revised estimate suggests nearly 6,500 CSTG in the spring population. This is a minimum estimate because some areas of suitable habitat remain unsearched and other areas need to be searched more intensively.

Activity patterns and movements

Columbian sharp-tailed grouse in Region 2 occupy seasonally distinct home ranges corresponding to the spring-fall and winter periods (Boisvert 2002, Collins 2004, Boisvert et al. 2005). Analysis of 1,775 telemetry locations of radio-marked grouse in northwestern Colorado indicated that 85 percent were within 2.0 km of the lek of capture from spring through fall (Boisvert et al. 2005). In comparison, of 100 winter locations, all were greater than 3.0 km from the lek of capture (Boisvert et al. 2005). Nearly 70 percent of all (n = 148) grouse tracked to wintering areas in northwestern Colorado moved greater than 7.0 km from where they were captured on a lek (Collins 2004, Boisvert et al. 2005). Using the 95 percent fixed-kernel estimator (Worton 1989) and minimum convex polygon method (Mohr 1947), Boisvert et al. (2005) estimated the median spring-fall home range size as 86 ha (mean = 153) and 61 ha (mean = 99), respectively. Spring-fall home range size did not differ between males and females. Using the 95 percent fixed kernel estimator, Collins (2004) calculated median spring-fall home range sizes for females that varied from 65 (mean = 85) to 1,168 ha (mean = 1,446). The greater variation in home range sizes and larger home ranges reported by Collins (2004) may have been the result of drought conditions causing the birds to use larger areas. Using the minimum convex polygon method, Marks and Marks (1987) and Giesen (1997) calculated mean spring-fall home range sizes of 110 and 187 ha, respectively, for CSTG occupying native habitats in western Idaho and northwestern Colorado.

Ulliman (1995b) and Boisvert (2002) are the only investigators to report winter home range sizes for CSTG due in part to the difficulty in accessing and locating grouse at this time of year. Ulliman (1995b) reported median winter home range sizes (90 percent adaptive kernel estimator) of 59 and 187 ha over two winters and attributed the difference to the severity of the winter, with grouse using smaller home ranges during the milder winter. Boisvert (2002) reported a median winter home range size (95 percent fixed kernel estimator) of 214 ha.

Mean winter home range sizes for prairie sharp-tailed grouse in Wisconsin averaged 149 ± 31 ha for females and 212 ± 26 ha for males (Gratson 1988). Studies by Ulliman (1995b) and Boisvert (2002) also showed a similar pattern of males having larger winter home ranges than females, but the differences were not significant. Both studies were based on small sample sizes of grouse and total locations per grouse. Therefore, caution must be used in interpreting the winter home range estimates.

Spring home range size of males in Washington was 11 to 46 ha (Hofmann and Dobler 1988a). Spring ranges of females are probably larger than those of males because females venture further from leks than males in search of nest sites. However, spring home ranges for females have not been measured, and home ranges for other seasons of the year are poorly documented. Collins (2004) attempted to estimate brood ranges from time of hatch until early September for broods raised in mine reclamation and shrubsteppe cover types. During moderate and severe drought years, median brood ranges in mine reclamation were 75 ha (n = 6 broods, range = 7–230 ha) and 69 ha (n = 9 broods, range = 27–196 ha), respectively, based on a minimum of 22 locations per brood. Median brood home ranges in shrubsteppe were exceptionally large: 197 ha (n = 5, range = 85–927 ha) during the moderate drought year and 2,173 ha (n = 6, range = 23–7,203 ha) during the severe drought year. Unusually large home ranges in shrubsteppe may have been an artifact of the poor condition of this cover type due to grazing. Continuation of grazing in conjunction with the ongoing drought probably exacerbated the problem. No grazing was allowed in the mine reclamation cover type where the data were collected. Under normal growing conditions, brood ranges are probably smaller within both cover types.

Breeding season

Communal display among male grouse has been described for several species (Hjorth 1970, Johnsgard 1973). Among the 12 species of grouse in North America, greater sage-grouse, Gunnison sage-grouse, greater prairie-chicken, lesser prairie-chicken, and sharp-tailed grouse all perform communal displays during the breeding season. Males gather on traditional breeding areas called "leks" or "arenas" where they perform elaborate courtship displays and vocalizations to attract females for breeding, and to defend their position on the lek against other males (Hjorth 1970, Johnsgard 1973). This pattern is referred to as lekking behavior. The surface area of the lek or arena is subdivided into a number of small, contiguous territories each occupied by an individual male (Rippin and Boag 1974a).

The lek or arena of sharp-tailed grouse is sometimes called a dancing ground. A sharp-tailed grouse lek can vary in size from less than 40 m^2 to over 200 m^2 depending on the number of males on the lek. At the core of the lek, males are usually spaced less than 5 m apart. Males on the periphery of the lek may be spaced farther apart and have less well-defined territorial boundaries.

Males depart wintering areas and start attending leks in late March, and continue through mid- to late June (**Table 5**). During this period, they seldom venture more than 1.6 km from the lek, and most (>80 percent) remain within 1 km of the lek from March through early June (Collins 2004, Boisvert et al. 2005). Males often continue to feed, loaf, and roost together when off the lek. They arrive on the lek about 30 minutes before sunrise and may remain for up to 3 hours after sunrise depending on weather and presence or absence of females. Some males may revisit the lek in the evening, but the intensity and duration of activity are less than in the morning. Leks may contain as few as two to over 40 males. Established leks may be used for many years, even decades. Of 31 leks located by Rogers (1969) in Moffat and Routt counties in the late 1950's and early 1960's, 17 were still active in spring 2006 (Colorado Division of Wildlife, unpublished data).

The lek mating system of CSTG is best described as male dominant polygyny (Connelly et al. 1998), and it is similar to the mating system of sage-grouse and prairie-chickens (Emlen and Oring 1977, Wittenberger 1978). The basic structure of the lek consists of a central ring of dominant males surrounded by two or three outer rings of successively less dominant males (Rippin and Boag 1974a, Moyles and Boag 1981). Males established on central territories mate more frequently and are predated less often than peripheral males (Rippin 1970, Moyles and Boag 1981).

Rippin and Boag (1974b) documented the presence of a non-territorial segment of the male population consisting primarily of subadults that do not attend leks unless more than 50 percent of the established males are removed. Rippin and Boag (1974b) further demonstrated that each lek appears to have its own associated group of non-territorial males. Males rarely attend more than one lek within a breeding season and return to the same lek each spring. The pair bond is limited to courtship on the leks. Males may obtain multiple mates in a single morning and over

Table 5. Timing of seasonal movements and breeding, nesting, brood-rearing, and winter activities of Columbian sharp-tailed grouse in USDA Forest Service Rocky Mountain Region.

Activity	Approximate timing (Peak)
Movements to breeding areas	Mid-March–mid-April (late March–early April)
Breeding season[1]	Late March–mid-June (late April–early May)
Nesting season[2]	Early May–mid-July (mid-May–mid-June)
Incubation	Mid-May–early July (late May–late June)
Hatching	Early June–early July (mid- to late June)
Brood-rearing	Early June–mid-September (mid-June–late August)
Fall lekking period	Mid-September–late October (late September–mid-October)
Movements to wintering areas	Mid-October–mid-December (late October–mid-November)
Winter season	Late October–early April (late November–mid-March)

[1]Spring lekking period.
[2]Includes renesting activities.

the course of the breeding season. Typically, only a small proportion of the males on the lek are successful in attracting and mating with a female (Kermott 1982, Landel 1989, Gratson et al. 1991, Gratson 1993). Of 47 established males on four leks in southern Manitoba, 23 (49 percent) were not observed to breed, 11 (23 percent) bred once, and 13 (28 percent) bred two to 11 times; nine of the 13 males that bred more than once accounted for 54 (75 percent) of 72 observed copulations (Gratson et al. 1991, Gratson 1993).

The primary display on the lek is the dance (**Figure 4**). During the dance, males rapidly stomp their feet, click the rectrices of their upturned tail, and hold their wings outward while producing a loud cork or popping note (Lumsden 1965, Hjorth 1970). Dances are interrupted by periods of freezes, when the male is silent and does not move, but remains in the dance posture. Periods of dancing and freezing are synchronized across the lek. Larger body size has a role in the male's ability to acquire a central territory (Tsuji et al. 1994), but of the central males, the smaller males have higher courtship rates and are more successful in mating (Gratson 1993). It appears that males that dance longer, click their tail feathers faster, and have a shorter interval between corks are most successful in attracting and mating with a female (Gratson 1993).

In addition to the cork sound, males produce six other vocalizations, primarily when they are on the lek (reviewed by Connelly et al. 1998).

1. Cackle - a cackling sound given during agonistic interactions. Given most frequently when females are on the lek, but increases in frequency from early to mid-morning if females are absent.

2. Chilk - a sharp, bark-like complex note of multiple energy peaks along a wide frequency range. Given most frequently when females are present on the lek. Possibly serves a mate-attraction function. Other evidence suggests it serves to interfere with the cork note of adjacent males trying to court a female.

3. Coo - a short, low frequency cooing produced by the syrinx and amplified by esophageal air sacs. Given most frequently when no females are present on the lek. Serves to denote presence of male to other males and to females off the lek.

Figure 4. Male Columbian sharp-tailed grouse displaying (dancing) on a lek. Photograph by Richard W. Hoffman.

4. Gobble - a gobbling sound of three to five notes, each comprised of an intricate frequency structure, separated by short intervals. Associated with agonistic interactions among males when establishing territories.

5. Whine - lingering, whining sound produced during agonistic interactions. Commonly given during face-offs along territorial boundaries.

6. Cork - popping sound that resembles a cork pulled from a bottle. Given when females are on the lek. Plays a strong function in mate choice by females.

7. Cluck - three note clucking sound given by both males and females when taking flight. Given at any time of year.

The precise sex ratio in the breeding population is unknown. Giesen (1999) ascertained gender from gonadal inspection of 93 adults and 163 juveniles harvested in Colorado. The sex ratios did not differ from 1:1 (adults = 1 male:1.2 females, juveniles = 1 male: 1.1 females). Giesen (1999) acknowledged that harvest samples may not be representative of the population, but stressed that there are no other data to indicate sex ratios markedly differ from 1:1.

Within Region 2, females start to visit leks regularly about mid-April. The peak of hen attendance usually occurs in late April and early May (**Table 5**). This peak may vary by 7 to 10 days from one spring to the next depending on snow cover and spring weather conditions. Females visit leks singly or in groups of two to five individuals. Unlike sage-grouse, where the number of females on the lek may equal or surpass the number of males, this rarely is the case with CSTG. It is common for only one female to be on the lek and seldom are there more than 10 females on the lek at one time, even on larger leks. However, over the course of a single morning during the peak of breeding activities, 10 or more hens may visit a lek of 20 to 25 males. The hens come and go, usually arriving just before or slightly after sunrise. They may walk on to the lek, but generally fly to the lek, land on the periphery, and walk towards the center. They remain on the lek for 15 to 30 minutes. When leaving, they usually walk to the periphery and fly off. Occasionally they walk off into the surrounding vegetation.

Lekking behaviors and lek attendance patterns of females are less understood than for males. No evidence has been collected to suggest that some females do not attend leks. Females may attend a single lek more than once or visit multiple leks. Unlike the males, females do not attend leks on a daily basis or defend territories on the leks (reviewed by Connelly et al. 1998). Their main purpose for attending the lek is to mate. However, females may visit leks without mating.

It is assumed that females only copulate once during the breeding season unless they are disturbed while mating or they attempt to renest. However, evidence to support (Tsuji 1996) or refute (Gratson et al. 1991) this contention is inconclusive. In addition, if females successfully copulate more than once, it is unknown whether the multiple copulations are performed with the same or different males. However, it is known that if the initial copulation attempt is unsuccessful, they may or may not mate with the same male. Attempts to copulate are often disrupted (Gratson et al. 1991), in which case the female must try to mate again during the same visit or during a later visit to the lek. In either case, she may or may not mate with the same male. Gratson et al. (1991) reported that 36 percent of 204 observed copulations were disrupted. Of the 74 females involved in the disrupted copulations, only 50 percent remated with the same male, 17 percent mated with the male that disrupted the initial copulation attempt, and 33 percent mated with a different male that was not involved in the initial copulation or disruption.

Males may pursue females after they leave the lek. These males continue to display to the female off the lek. While it is believed that most copulations take place on the lek, some mating may occur off the lek (Sexton 1979). The extent of this behavior is unknown.

Females move significantly longer distances and exhibit more variation in their movements during the breeding season than males do. Based on two studies in northwestern Colorado, no males ($n = 76$) moved greater than 1.6 km from their lek of capture during spring, whereas about 20 percent of 208 females ventured over 2.0 km from their lek of capture (Collins 2004, Boisvert et al. 2005). The longest movement for a female during the breeding season was 10.1 km, compared to only 1.6 km for a male.

Nesting season

Telemetry data suggest that all females attempt to nest (Connelly et al. 1998). Of 183 radio-marked

females (subadults = 36, adults = 147) monitored during the nesting season in northwestern Colorado from 1999 to 2003, at least 180 (98 percent) attempted to nest (Boisvert 2002, Collins 2004). No definitive data exist on when females select a nest site, but Bergerud and Gratson (1988) and Gratson (1988) suggest that nest site selection may occur before mating. Males have no role in nest-site selection, construction of the nest, incubation of the eggs, or care of the young (Tirhi 1995, Connelly et al. 1998). In Region 2, nest construction and initiation of laying begins in early to mid-May, with incubation starting in mid- to late May, and hatching occurring in mid-to late June (**Table 5**; Boisvert 2002, Collins 2004). Photoperiod directly controls the timing of nesting activities, but it may be accelerated or delayed up to 14 days annually by climatic conditions. Compared to other portions of the range, breeding and nesting activities of CSTG in Region 2 are naturally later because the birds live at higher elevations.

Several studies in northwestern Colorado documented timing of nesting activities. Boisvert (2002) reported that incubation began on 19 May 1999 and 7 May 2000; the latest any female began incubating their initial nest was 13 June in both years. The peak of incubation (equal to middle third of when hens were incubating their initial clutches) was 27 to 31 May 1999 and 17 to 22 May 2000. Hatching dates ranged from 7 June to 14 July (including renests). The differences between years were attributed to warmer and drier conditions in 2000 (moderate drought year) compared to 1999 (normal year). In another study, initiation dates for initial nests ranged from 14 May to 8 June 2001 and 7 May to 10 June 2002, peak of incubation (defined above) ranged from 20 to 23 May 2001 and 15 to 20 May 2002, and peak of hatch ranged from 14 to 19 June 2001 and 10 to 16 June 2002 (Collins 2004). Hatch dates for renest clutches ranged from 2 to 14 July in 2001 and 2002. Collins (2004) emphasized that timing of nesting activities in 2001 and 2002 was probably early because of moderate (2001) to severe (2002) drought conditions. Giesen (1999) estimated hatch dates from wing samples collected in northwestern Colorado from 1980 to 1997. In 10 of the 18 years of data, the peak week of hatch was estimated as 16 to 22 June. Hatch dates ranged from 21 May to 19 July, and the median hatch date was 22 June.

The nest is a shallow depression in the ground lined with dried vegetation and several soft body feathers. The slightly oval-shaped depression ranges from 10 to 15 cm in diameter and 3 to 8 cm deep (Hart et al. 1950). Females start laying one to three days after they copulate and lay subsequent eggs at one to two day intervals until the clutch is complete (Connelly et al. 1998). Females may lay eggs anytime during the day, but most commonly, they lay during late morning to mid-afternoon. The female often covers the eggs after laying. Hart et al. (1950) described the eggs of the Columbian subspecies as being an irregular olive color with a slight amount of pale blue showing through, and with a light, variable speckling of dark chocolate brown. The color of the eggs fades as the incubation period progresses. Eggs of the southern forms of the sharp-tailed grouse tend to be lighter than those of the northern forms (Bendire 1892). Average dimensions (length X width) of the eggs range from 42.5 to 44.5 mm X 30.9 to 34.0 mm (Connelly et al. 1998).

Incubation is entirely by the female and does not begin until the last egg is deposited (Connelly et al. 1998). The female usually leaves the nest to feed for approximately 30 to 45 minutes in the morning and again in the evening (Hart et al. 1950). Unlike during the laying period, the female does not cover the eggs when leaving for an incubation break.

Sharp-tailed grouse may renest if the first nest is destroyed or abandoned due to disturbance (Connelly et al. 1998). Not all females that lose or abandon their first clutch will attempt to renest. The renesting rate (proportion of females that survived an initial nest failure that attempted to renest) varies with age. The likelihood of renesting is greater if the first clutch is lost or abandoned during the laying period or early in the incubation process. The longer a female incubates her first clutch before it is lost or abandoned, the less likely she will attempt to renest. Females that attempt to renest will revisit the lek to mate and initiate the second clutch with 10 to 14 days of losing the first clutch. Females may renest more than once, but multiple renest attempts in Region 2 are unusual.

Giesen (1997) reported that 92 percent of the CSTG females he monitored nested within 2.0 km (median = 1.4 km) of their lek of capture. Similarly, Meints (1991), Apa (1998), and McDonald (1998) all reported average movements to nests of less than 2.0 km. Boisvert et al. (2005) documented a median movement to nest sites of 0.63 km (range = 0.09–11.30 km) for 58 CSTG females in northwestern Colorado; 86 percent of all females in this study nested within 2.0 km of their lek of capture. In another Colorado study, Collins (2004) recorded 130 movements from lek of capture to initial nest sites. The median movement was 0.98 km (range = 0.15–21.75 km), with 82 percent of all females nesting within 2.0 km of their lek of capture. Collins (2004) also found that 94 percent of 18

movements (median = 0.76 km, range = 0.16–3.71 km) to renest sites were within 2.0 km of the lek of capture, and that median movement between initial and renest sites was 0.54 km (*n* = 18, range = 0.20–3.47).

Recent studies indicate that female CSTG not only exhibit fidelity to leks, but also to nesting areas between years. Six females monitored by Boisvert et al. (2005) over two consecutive nesting seasons nested within 250 m of their previous years' nests. The median distance between successive nest sites for 28 females monitored by Collins (2004) was 310 m (range = 20–5,270 m), with 85 percent nesting within 400 m of their previous years' nest. Collins (2004) was able to follow two females through three nesting seasons. These females selected initial nest sites in three consecutive years that were within 9 and 190 m of each other.

Summer/brood-rearing season

By mid- to late June, males are visiting and spending less time on leks, but they continue to show fidelity to areas near the lek. Boisvert et al. (2005) reported that 96 percent of 23 radio-marked males remained within 2.0 km of the lek where they were captured throughout the summer. The median summer movement from lek of capture was only 400 m. In the same study, 41 unsuccessful females (females that fail to hatch a clutch of eggs) moved farther (median = 840 m) from their lek of capture during summer than males, but 71 percent still remained within 2.0 km of their lek of capture (Boisvert et al. 2005). Collins (2004) reported longer median movements (males = 1,140 m, females = 2,700 m) from leks of capture during summer than Boisvert et al. (2005). Collins (2004) attributed the longer movements in part to the drought conditions that prevailed during the two years of his study.

Males continue to associate in flocks during summer. Flock size can vary from only a few individuals to 10 to 15 birds. Some males may leave the flocks and be alone for a period of time. Unsuccessful females also associate in flocks during summer, but they tend to associate in smaller groups (two to five birds), and they are more commonly found alone than males are. There appears to be no social organization or continuity within flocks. An individual may be found alone one day and part of a flock the next. Even within the same day, an individual may be alone part of the day and associated with a flock at other times.

While males occasionally visit leks during summer, females do not. When males do visit leks in summer, they are only there for a short period of time. They most often just sit on the lek and only briefly engage in any display activity. Both males and females use the same general summering areas year after year unless drought conditions cause them to move elsewhere. In normal and above average precipitation years, they continue to use the shrubsteppe zone during the summer. In drier years, they may move into the mountain shrub zone. Collins (2004) documented this behavior for CSTG breeding in northwestern Colorado during the severe drought year of 2002.

Females and young abandon the nest site soon after the last egg hatches. Newly hatched young are precocial, meaning they are fully-feathered and capable of walking and foraging on their own. They require regular brooding by females during the first two weeks of life and less frequent brooding as they get older. By three weeks of age, they can regulate their own body temperature and no longer require brooding.

Median movements from nest sites to brood-rearing areas have been reported as 400 (*n* = 25, Boisvert et al. 2005) and 780 m (*n* = 54, Collins 2004) and range from 100 m to nearly 6.0 km. Approximately 78 percent of the successful females in these two studies raised their broods within 1 km of where they nested. This indicates that females select nest sites within or immediately adjacent to suitable brood habitat. In the study conducted by Collins (2004), four successful females made unusually long (>3.5 km) movements to brood-rearing areas. Three of the four long movements were made during the severe drought year of 2002. Excluding these longer movement, movements from nest to brood-rearing areas documented by Collins (2004) are nearly identical to those reported by Boisvert et al. (2005).

During summer, CSTG forage during the cooler parts of the day and rest in the shade during mid-day. Marks and Marks (1987) found no evidence that CSTG sought free water during summer. The mean daily movement from time of hatch until 1 August for 17 broods monitored by Meints (1991) in southeastern Idaho was 58 ± 17 m. Chicks are capable of short flights at 7 to 10 days of age, but they usually walk and generally freeze in place or run and hide when disturbed (Hart et al. 1950). When a brood is disturbed, the hen will fake injury in an attempt to distract and lead the intruder away (Hart et al. 1950). The younger the brood, the closer the hen can be approached before she moves and tries to distract the intruder. As the brood gets older, the hen is more likely to flush without performing any distraction behavior. Even as the flying ability of juveniles improves, they prefer to hide or

sit tight rather than flush until their flying abilities approach those of adults.

Males, successful females and their broods, and unsuccessful females use the same general areas during summer but seldom associate in the same flocks. Later in summer, individual broods may combine to form gang broods. By late August, it is not uncommon to observe different age classes of chicks accompanied by two or more females. Brood dispersal begins in late summer (late August–early September). Brood dispersal is a gradual process, with individual broods separating at different times and individuals within a brood leaving at different times.

Fall season

Brood dispersal continues into the fall period. In mid- to late September, males start to attend leks on a regular basis (**Table 5**). Not all leks active in spring are active in fall (R.W. Hoffman personal observation). This is mainly true for smaller (<10 males) leks, but also has been noted for leks with over 20 males during the spring (R.W. Hoffman personal observation). Efforts directed at trapping CSTG on leks in the fall indicate that some females visit the leks at this time. Of 98 CSTG trapped on leks during fall in northwestern Colorado, 14 (four adults, 10 juveniles) were females and 84 (65 adults, 19 juveniles) were males (Boisvert 2002, Collins 2004).

Fall lek attendance may serve several functions:

- allow adult males to reaffirm or possibly improve their position on the lek
- provide juvenile males and juvenile females an opportunity to learn where leks occur
- allow some juvenile males the opportunity to establish themselves as peripheral males.

It appears as if adult females are occasionally attracted to the leks in fall possibly out of social curiosity (i.e., presence of other grouse) more so than for any other reason. Although males display to females, they do not attempt to copulate with them (R.W. Hoffman personal observation). In some cases, males treat juvenile females as if they are males, often chasing them off the lek. Males in fall do not react to the presence of females on leks with the same intensity as they do in spring. By far, the majority of activity on leks in fall appears to be aggressive activity directed at other males.

Flocking tendencies of sharp-tailed grouse during fall are highly variable. They may occur singly, in small groups of two to 10 birds, and in large flocks exceeding 30 birds. The mean number of grouse observed per observation (n = 14) in south-central Wyoming during the fall period was 7.1, and the maximum flock size was 30 individuals (Oedekoven 1985). Flock counts obtained during late fall in northwestern Colorado averaged 14.9 grouse (Hoffman 1980). Of 21 encounters, 18 were with flocks varying from two to 101 individuals, and three (14 percent) were of lone birds (Hoffman 1980). In Utah, average flock sizes ranged from 12.7 to 32.3 grouse per flock in late fall (late October to early December). Despite the wide variation in flock sizes during fall, overall, flock sizes tend to be greatest at this time of year (Hart et al. 1950). Larger flocks are often the result of the grouse concentrating near areas of abundant food, such as along the edge of harvested wheat fields. These larger flocks have no definite organization, may disband during the day, and frequently vary in number from one day to the next (Hart et al. 1950).

Boisvert et al. (2005) documented that no radio-marked grouse in 1999 left the spring-fall range until 14 November. In fall 2000, movements from the spring-fall range started in late October, and 84 percent of the radio-marked birds were on wintering areas by mid-November (Boisvert et al. 2005). The earlier departure in 2000 compared to 1999 was likely due to the earlier onset of winter conditions in 2000. Regardless of when grouse started to leave the spring-fall range, in both years, females departed before the males (Boisvert et al. 2005). Kobriger (1965) and Gratson (1988), along with Boisvert (2002), attributed the later departure of males in fall and their subsequent earlier return in the spring to their greater attachment to lek sites.

Winter season

When herbaceous vegetation and agricultural crops become snow covered, CSTG move to riparian zones and patches of mountain shrubs (Marks and Marks 1988, Schneider 1994, Ulliman 1995b, McDonald 1998, Boisvert 2002). This usually happens by mid-December (**Table 5**). Areas used for wintering are often spatially distinct from areas used for breeding, nesting, and brood-rearing (Marks and Marks 1988, Meints 1991, Collins 2004, Boisvert et al. 2005). In mild winters, CSTG may continue to use open grassland, including Conservation Reserve Program (CRP) and agricultural lands, and shrubsteppe cover types (Ulliman 1995b, McDonald 1998), or they may move between the

mountain shrub and more open cover types depending on snow conditions. This rarely happens in Region 2 because snow covers most of the spring-fall range from mid-December through mid- to late March. Thus, during most winters in Region 2, there is a distinct movement of CSTG from the spring-fall range to wintering areas (Oedekoven 1985, Giesen 1997, Collins 2004, Boisvert et al. 2005).

Distances moved between spring-fall and winter ranges can vary from less than 0.5 km to greater than 40 km (**Table 6**). Boisvert et al. (2005) found no differences in movements to wintering areas between males (median = 21.5 km, range = 4.2–36.5 km, *n* = 13) and females (median = 21.4 km, range = 3.1–41.5 km, *n* = 17) or between CSTG breeding in CRP (median = 21.5 km, range = 3.4–36.5 km, *n* =5) and mine reclamation lands (median = 21.4 km, range = 4.2–41.5 km, *n* = 25). In contrast, Collins (2004) documented significantly longer movements to wintering areas for females breeding in shrubsteppe (median = 5.9 km, range = 0.5–42.5 km, *n* = 38) and mine reclamation (median = 8.6 km, range = 1.3–48.9 km, *n* = 33) compared to males breeding in shrubsteppe (median = 2.0 km, range = 0.5–8.9 km, *n* = 10) and mine reclamation (median = 6.9 km, range = 0.5–28.6 km, *n* = 37).

The literature is unclear whether males typically remain closer to leks during winter than females do. McDonald (1998) reported females moving farther to wintering areas than males on one study area, whereas the opposite was documented on another study area. Ulliman (1995b) found that males remained closer to leks than females during both years of his study. The studies by McDonald (1998) and Ulliman (1995b) had small sample sizes (**Table 6**) and may not be indicative of the populations they studied. Boisvert et al. (2005) found that males and females moved similar distances to wintering areas, but this study also had a small sample size of males (**Table 6**). Collins (2004) documented the largest number of movements to wintering areas by CSTG (**Table 6**). Although data from this study indicated that females moved farther than males to wintering areas, some males also moved long (>20 km) distances, and some females wintered close (<2 km) to their lek of capture.

Ulliman (1995b) hypothesized, and McDonald (1998) concurred, that females move farther to wintering areas than males do to avoid harassment and competition for food near leks. This implies at least partial gender segregation during winter. Collins (2004) and Boisvert et al. (2005) found limited evidence to

Table 6. Distances (km) moved by Columbian sharp-tailed grouse from their lek of capture to wintering areas.

Gender	*n*	Median	Mean	Range	Location	Reference
Male	13	21.5	20.0	4.2–36.5	Colorado	Boisvert et al. 2005
Female	17	21.4	22.1	3.1–41.5	Colorado	Boisvert et al. 2005
Male	47	5.4	6.5	0.5–28.6	Colorado	Collins 2004
Female	71	7.5	10.4	0.5–48.9	Colorado	Collins 2004
Male	3	1.1	—	0.7–1.5	Colorado	Giesen 1997
Female	1	6.7	—	—	Colorado	Giesen 1997
Male	9	—	2.8	0.8–9.7	Washington	McDonald 1998
Female	4	—	2.3	1.1–4.3	Washington	McDonald 1998
Male	2	—	1.0	0.2–2.6	Washington	McDonald 1998
Female	6	—	5.5	0.5–11.5	Washington	McDonald 1998
Male	6	0.6	—	0.5–2.2	Idaho	Ulliman 1995b
Female	6	3.2	—	1.1–9.9	Idaho	Ulliman 1995b
Male	4	2.0	—	1.2–3.7	Idaho	Ulliman 1995b
Female	9	3.4	—	0.8–9.2	Idaho	Ulliman 1995b

support this hypothesis. First, neither Collins (2004) nor Boisvert et al. (2005) found that males necessarily wintered in the closest suitable habitat to their lek of capture. Boisvert et al. (2005) reported that no radio-marked grouse (male or female) wintered within 3 km of their lek of capture even though suitable winter habitat occurred within 2 km of all the leks trapped in their study. Second, both Collins (2004) and Boisvert et al. (2005) documented males and females wintering in the same geographic area. Collins (2004) also documented males and females captured on the same lek wintering in the same general area. It is possible, as noted by Collins (2004), that females using the same general area as males may segregate from males on a finer scale than studies have documented to date.

Giesen and Connelly (1993:327) stated, "Columbian sharp-tailed grouse seem to move farther to wintering habitats in regions lacking a broad distribution of winter food resources." Results of studies within Region 2 in northwestern Colorado contradict this statement (Collins 2004, Boisvert et al. 2005). Northwestern Colorado and south-central Wyoming have not experienced large-scale habitat conversions that have occurred in many other areas within the range of CSTG (Ritcey 1995, McDonald and Reese 1998, Schroeder et al. 2000, Utah Division of Wildlife Resources 2002). Consequently, landscapes, and particularly the mountain shrub and quaking aspen (*Populus tremuloides*) cover types used for winter habitat (Boisvert 2002), have remained relatively intact, comprising greater than 20 percent of the available cover types in this area (Hoffman 2001). Despite the abundance of winter habitat near leks, some grouse still moved long distances to wintering areas (Collins 2004, Boisvert et al. 2005).

Boisvert et al. (2005) speculated that CSTG may disperse throughout the available winter range rather than concentrate in the nearest suitable winter habitat in relation to where they breed to reduce their vulnerability to predators. During the winter, CSTG feed in the upper branches of tall deciduous shrubs (Schneider 1994) where they are exposed and possibly more susceptible to avian predators. Furthermore, there is little or no hiding cover at ground level at this time of year because of snow conditions. Large concentrations of grouse in this situation may attract predators and increase their mortality rates. Conversely, if they are dispersed throughout the available winter range, their chances of survival may be greater. For this to be true, the survival advantage gained by this behavior must outweigh the increased risk of moving long distances. Hamerstrom and Hamerstrom (1951) suggested that long distance movements were historically common for plains and prairie sharp-tailed grouse under pristine conditions. If this is also true for CSTG, then longer movements should not be interpreted as indicative of areas having low suitability for sharp-tailed grouse as implied by Giesen and Connelly (1993).

Boisvert et al. (2005) suggested that CSTG breeding in non-native cover types, such as CRP and mine reclamation lands, may move farther to wintering areas than those breeding in native shrubsteppe. This may be due to the attractiveness of CRP and mine reclamation lands as lek sites. Conservation Reserve Program and mine reclamation lands account for only 4 percent of the occupied range of CSTG in northwestern Colorado, but they support about 44 percent of the known active leks (Hoffman 2001). It appears that CSTG will move longer distances between breeding and winter ranges to use this limited resource. In support of this contention, Collins (2004) documented that male (median = 6.9 km, range = 0.5–28.6 km, n = 37) and female (median = 8.6 km, range = 1.3–48.9 km, n = 33) CSTG captured on leks in mine reclamation traveled significantly longer distances to and from wintering areas than their counterparts captured on leks in native shrubsteppe (male: median = 2.0 km, range = 0.5–8.9 km, n = 10; female: median = 5.9 km, range = 0.5–42.5 km, n = 38).

Once on winter range, CSTG are relatively sedentary. Median daily movements of CSTG during winter in southeastern Idaho were 221 and 286 m for females and males, respectively (Ulliman 1995b). Fidelity of CSTG to wintering areas is poorly understood. Based on the few CSTG followed during successive winters, most returned to the same general area where they wintered the previous year (Collins 2004, Boisvert et al. 2005). Also, CSTG captured on the same leks in successive springs moved to the same general wintering areas (Collins 2004, Boisvert et al. 2005), suggesting that CSTG from the same breeding population use the same traditional wintering areas year after year. Boisvert et al. (2005) found that, although suitable winter habitat occurred in all directions from where CSTG were captured, movements to wintering areas were nonrandom, further suggesting that CSTG use traditional wintering areas. Finally, in searching for and locating CSTG during winter, Boisvert et al. (2005) and Collins (2004) discovered that large expanses of apparently suitable winter habitat were devoid of grouse and that they consistently found CSTG in the same areas each winter.

Snow roosting is an adaptation for staying warm, conserving energy, and remaining inconspicuous. Columbian sharp-tailed grouse roost beneath the surface of the snow at night during winter when snow conditions are suitable (Hart et al. 1950, Marks and Marks 1987, McDonald 1998). They also commonly roost beneath the snow during the day when they are not feeding. During severe winter weather and low temperatures, sharp-tailed grouse remain in their burrows through the night and may emerge only once during the day to feed (Gratson 1988). Columbian sharp-tailed grouse snow roost in small openings within and immediately adjacent to patches of shrubs, but they seldom roost within the shrub patches (Odekoven 1985, Marks and Marks 1987, McDonald 1998). This may be because soft snow suitable for roosting accumulates around the edges of shrub patches, creating optimal burrowing conditions.

Other subspecies of sharp-tailed grouse may roost in trees during the day and at night when snow conditions are not suitable for snow roosting (Gratson 1988). This behavior has been rarely reported for CSTG. Although CSTG may perch in trees to feed or when flushed from the ground, they seldom roost there. The only study that mentions CSTG roosting in trees at night during winter is Hart et al. (1950:38), who stated "when the snow is crusted, and occasionally at other times, the birds pass the night on low limbs of shrubs and trees." Marshall and Jensen (1937) reported that CSTG roosted in bushes (but not trees) protruding above the snow during winter because of the snow being crusted.

Columbian sharp-tailed grouse in eastern Washington burrowed in the snow when depths exceeded 28 cm and the surface was not crusted (McDonald 1998). Prairie sharp-tailed grouse in Wisconsin snow burrowed when snow depths exceeded 18 cm (Gratson 1988). The average length of snow burrows in eastern Washington was 73 ± 12 cm (range = 28–180 cm). Gratson (1988) reported that night burrows (mean = 240 ± 50 cm) were longer than daytime burrows (mean = 140 ± 70 cm). Neither investigator provided data on depth of snow burrows. However, because the submerged grouse may need to escape quickly, they likely do not burrow very deep. The average depth of a night roost for white-tailed ptarmigan (*Lagopus leucura*) is 160 mm (range = 90–270 mm) with about 30 to 50 mm of snow covering the submerged bird (Braun and Schmidt 1971). Since sharp-tailed grouse are larger than ptarmigan, their burrows should be slightly deeper, but the amount of snow above the bird is probably about the same. Sharp-tailed grouse do not plunge into the snow like ruffed grouse (*Bonasa umbellus*; Runkles and Thompson 1989). Instead, they dig, push, wiggle, and tunnel their way beneath the snow. Occasionally, when snow roosting during the day, they will stick their head above the snow surface.

Boisvert et al. (2005) noted a positive elevation gain (median = 102 m, range = 5–383 m) associated with movements from spring-fall to winter ranges. Collins (2004) also mentions movements to higher elevations during winter but did not quantify this information. Two possible reasons why CSTG move up in winter are (1) moisture conditions at higher elevations are more conducive to supporting tall deciduous shrubs required during winter, and (2) snow conditions are better (i.e., deeper and softer snow) for roosting

Flocking may be advantageous for sharing or obtaining information on food distribution and for predator detection, both of which may increase survival of individual flock members. At no time are the flocking tendencies of sharp-tailed grouse more evident than during winter when food availability and hiding cover are most limited due to snow accumulation. Sharp-tailed grouse are less likely to be observed alone during winter than at any other time of the year, with the exception of females during the nesting season. Of 56 encounters of CSTG during winter in northwestern Colorado reported by Boisvert (2002), only 9 percent were of lone birds and 91 percent were of flocks containing two to 30 individuals (mean = 6.9, median = 5.5). Thirty-five winter flocks encountered in south-central Wyoming averaged only 3.7 grouse (Oedekoven 1985). Average mid-winter (January and February) flock sizes in Utah ranged from 4.9 to 8.3 grouse (Hart et al. 1950). In western Idaho, winter flock size (n = 88) averaged 5.6 ± 6.4 grouse; the largest flock contained 32 grouse (Marks and Marks 1987). In southeastern Idaho, Meints (1991) reported average winter flock sizes of 22 ± 44 (n = 36) and 5 ± 3 (n = 32) grouse in two different areas. The larger flock size occurred in an area where CSTG concentrated in grain fields to feed and moved to mountain shrub habitats during the day. No grain fields occurred in the area where the smaller flocks were found.

Hart et al. (1950) and Gratson (1988) reported that flock sizes of sharp-tailed grouse are largest during early winter and decrease in size as the winter progresses and snow cover increases. This is contrary to the prediction that grouse should join flocks when food availability decreases. Gratson (1988) found that flocking tendencies of sharp-tailed grouse in Wisconsin were related to snow burrowing opportunities more than food availability. At snow depths that allowed grouse to

snow burrow, birds associated in smaller flocks. When snow was insufficient for burrowing and the birds had to roost exposed on the surface of the snow, smaller flocks joined to form larger flocks. These data are consistent with the hypothesis that grouse join flocks when they are most conspicuous. When grouse can snow burrow, they are conspicuous only when feeding; thus, the need for increased vigilance owing to flocking is less (Gratson 1988).

Habitat

General

At the ecosystem level, CSTG inhabit the Temperate Semi-desert, Temperate Dry Steppe, and Temperate Steppe Mountain ecoregions of the United States (Bailey 1995, 1998). These regions receive an average of 5 to 50 cm of precipitation per year, much of which falls as snow during winter. Mean summer temperatures range from 10 to 34 °C, and winter temperatures range from −14 to 8 °C. The terrain is diverse, varying from broad, relatively flat expanses to gentle rolling hills and low mesas to steep, mountainous slopes. The vegetation types growing within the different ecoregions are equally diverse due to topography, soils, moisture conditions, elevation, and aspect.

Columbian sharp-tailed grouse prefer to use moderate terrain (slopes ≤ 10 to 20°; Marks and Marks 1987) and associated vegetation types, except during winter when they may use vegetation types on steeper slopes. They have a decided preference for habitat edges in native cover types. Areas with a mosaic of cover types are preferred over large continuous patches of uniform cover. Depending on the geographic area, elevations where CSTG occur can range from less than 500 m to more than 2,500 m. Native vegetation types associated with the presence of CSTG are sagebrush steppe (*Artemisia-Agropyron*), shrubsteppe (*Artemisia-Symphoricarpos-Amelanchier-Prunus-Purshia-Agropyron*), mountain mahogany-oak shrub (*Cercocarpus-Quercus*), fescue-wheatgrass (*Festuca-Agropyron*), wheatgrass-bluegrass (*Agropyron-Poa*), aspen-shrub (*Populus tremuloides-Amelanchier-Prunus*), mountain shrub (*Amelanchier-Prunus-Quercus* or *Acer-Amelanchier*), hawthorn (*Crataegus* spp.), juniper-shrub (*Juniperus-Artemisia-Amelanchier*), and riparian (*Salix-Betula-Alnus*).

Columbian sharp-tailed grouse may use a variety of plant communities to meet their seasonal habitat needs. Studies have shown that they typically occupy grass-low shrub (<1 m) dominated communities during spring, summer, and fall, and tall shrub (>1 m) cover types during winter (Marshall and Jensen 1937, Hart et al. 1950, Marks and Marks 1987, Ulliman 1995b, Giesen 1997, Apa 1998, McDonald 1998, Boisvert 2002, Collins 2004). Shrubs are a critical component of winter habitat. Columbian sharp-tailed grouse show greater flexibility in the proportion of shrubs that comprise use areas at other times of the year. During spring through fall, CSTG use grasslands with little or no shrubs in the composition as well as shrub-grass cover types with up to 40 percent shrub cover. The key factor is the amount of cover provided by the vegetation more than the actual species composition. Whether it is a shrub- or grass-dominated landscape, a certain height and density of vegetation is required. The growth form of the grass component also appears to be an important cover consideration, with bunchgrasses providing better cover than sod-forming grasses.

The CSTG is a habitat generalist and can adapt to moderate alterations in the native landscape. For example, CSTG may continue to use sagebrush rangelands that have been sprayed or burned and reseeded with non-native grasses, provided adequate cover remains. Columbian sharp-tailed grouse also can use and, in some cases, thrive in artificially-created cover types. For instance, CSTG may use cultivated croplands, such as wheat (*Triticum* spp.) and alfalfa (*Medicago sativa*), at certain times of the year (Hart et al. 1950, McDonald 1998). Croplands must occur in close proximity to permanent cover that provides nesting, brood-rearing, and winter habitat to benefit CSTG. Large blocks of agricultural lands will not support sharp-tailed grouse. More recently, CSTG have been documented using CRP and mine reclamation lands (Sirotnak et al. 1991, Ulliman 1995b, Apa 1998, McDonald 1998, Hoffman 2001, Boisvert 2002, Collins 2004). Conservation Reserve Program and mine reclamation lands (**Figure 5**) have been associated with increases in CSTG populations in Utah, Idaho, and Colorado (Ulliman et al. 1998, Hoffman 2001, Utah Division of Wildlife Resources 2002).

Even though CSTG select habitats predominantly based on structural characteristics of the vegetation and secondarily on species composition, this does not negate the significance of certain plant species. Common native plants found throughout the range of CSTG in the western United States that have been identified as being important for cover and/or food include big sagebrush, Saskatoon serviceberry (*Amelanchier alnifolia*), chokecherry (*Prunus virginiana*), hawthorn, water birch (*Betula occidentalis*), bluebunch wheatgrass (*Pseudoroegneria spicata*), western wheatgrass

Figure 5. Conservation Reserve Program (top) and mine reclamation lands (bottom) bordering native shrubsteppe and mountain shrub communities provide ideal breeding, nesting, and brood-rearing habitats for Columbian sharp-tailed grouse in northwestern Colorado. Photographs by Richard W. Hoffman.

(*Pascopyrum smithii*), basin wildrye (*Leymus cinereus*), Idaho fescue (*Festuca idahoensis*), Sandberg bluegrass (*Poa secunda*), arrowleaf balsamroot (*Balsamorhiza sagittata*), buckwheat (*Eriogonum* spp), hawksbeard (*Crepis* spp.), hawkweed (*Hieracium* spp.), lupine (*Lupinus* spp.), knotweed (*Polygonum* spp.), and pale agroseris (*Agroseris glauca*). Non-native plants frequently associated with CSTG habitats include alfalfa, common dandelion (*Taraxacum officinale*), yellow salsify (*Tragapogon dubius*), and prickly lettuce (*Lactuca serriola*).

In Region 2, CSTG occur in the transition zone between the arid sagebrush rangelands and the start of the aspen-conifer forests at elevations ranging from 1,890 to 2,591 m (Oedekoven 1985, Hoffman 2001).

This is the highest elevation at which CSTG occur throughout their current range. Climatic conditions vary from semi-arid to continental. Large diurnal and seasonal temperature changes occur throughout the region. Average annual precipitation ranges from less than 25 cm at Craig, Colorado to 31 cm at Dixon, Wyoming to 127 cm near Steamboat Springs, Colorado. Most precipitation falls as snow from November through March and as snow or rain during April and May. Daily temperatures in summer range from 4 to 33 °C. Maximum daytime temperatures during winter range from −12 to 4 °C. The average annual temperature varies from 4.6 to 5.4 °C depending on location. Freezing temperatures are likely during some part of the day from October through April.

The natural progression of vegetation types is from sagebrush-grass to shrubsteppe to mountain shrub to aspen to aspen-conifer to conifer. Small aspen patches are commonly scattered throughout the mountain shrub type. Narrow-leafed cottonwood (*Populus angustifolia*) grows along the rivers and many of the larger creek bottoms; adjacent areas have been largely converted to grass-hay meadows, alfalfa, pastureland, or wheat (Colorado only). Wheat fields and pasture lands also extend into the uplands within the shrubsteppe and mountain shrub types. Many wheat fields in the upland sites are currently enrolled or were formerly enrolled in the CRP. These fields primarily support stands of non-native grasses, such as smooth brome (*Bromus inermis*) and intermediate wheatgrass (*Thinopyrum intermedium*). Reclaimed coal mine lands are a minor but important part of the landscape in northwestern Colorado (Hoffman 2001, Boisvert 2002, Collins 2004). Mine reclamation lands occur mainly within the shrubsteppe and mountain shrub vegetation types, but they may extend into the sagebrush-grass and aspen types. Mine reclamation lands resemble CRP lands but contain a greater diversity of native and non-native grasses and forbs compared to CRP (Boisvert 2002). Further, mine reclamation lands may include a shrub component depending on the original seed mixture, planting method, and growing conditions (Boisvert 2002, Collins 2004).

Breeding habitat

Columbian sharp-tailed grouse leks are typically positioned on elevated sites in open areas where the vegetation is short and sparse (Hart et al. 1950, Rogers 1969, Parker 1970, Ward 1984, Boisvert 2002). The actual lek site is usually flat. Data collected by the CDOW in northwestern Colorado revealed that 83 percent of 141 leks occurred on elevated sites, such as knolls, ridges, or benches, where the slope was 2 percent or less (**Table 7**). Seven of nine lek sites in south-central Wyoming described by Oedekoven (1985) were in small, grassy openings on relatively flat terrain surrounded by mixed shrub or sagebrush cover. The average slope at lek sites in south-central Wyoming was 4 ± 3 percent (Klott and Lindzey 1989). Of 52 lek sites classified by Hart et al. (1950) in Utah, 32 were on hills with a definite elevation advantage over the surrounding area, and 20 were on flats with only a slight but obvious elevation advantage over the surrounding area. Four of five leks in southeastern Idaho described by Ward (1984) were along low ridges and one was on a flat; the average slope was 2 percent.

Boisvert (2002) measured seven macrohabitat variables at 16 lek sites in CRP and mine reclamation and found that topographic location was the only variable that was significantly different between lek and random sites. Of 12 microhabitat variables measured at the same lek and random sites, five were different (Boisvert 2002). Lek sites tended to have lower species richness, slightly less grass cover, substantially less shrub cover, more bare ground, and lower visual obstruction readings than random sites did.

Visibility and audibility are key features affecting where leks are situated (Wiley 1978, Ward 1984). Elevated sites promote attraction of females to leks by maximizing the sound transmission of males (Baydack 1988). Sparse vegetation on the lek further promotes attraction of females to the lek by not muffling the sounds of males. The openness of the lek also allows for greater visibility to detect predators, facilitates the ritualized displays of males, promotes easier movements on the lek, and provides females an unrestricted view of males on the lek.

Columbian sharp-tailed grouse appear to tolerate a greater range of cover and greater amounts of cover (especially shrubs) on the lek than other subspecies of sharp-tailed grouse and other species of prairie grouse do. In southwestern Manitoba, lek sites of prairie sharp-tailed grouse supported less than 1 percent shrub cover (Baydack 1988). Shrub cover at five CSTG leks in southeastern Idaho averaged 7 percent (Ward 1984). Shrub cover at CSTG leks in native vegetation types in south-central Wyoming averaged 11.1 ± 7.4 percent (Klott and Lindzey 1989). Shrub cover at leks in CRP and mine reclamation in northwestern Colorado did not exceed 1.5 percent (Boisvert 2002). Columbian sharp-tailed grouse leks in south-central Wyoming had greater

Table 7. Characteristics of Columbian sharp-tailed grouse lek sites in northwestern Colorado based on data collected by the Colorado Division of Wildlife.

Characteristic	*n*	Percent
Cover type		
Sagebrush[1]	87	35
Conservation Reserve Program	53	21
Grass hay-pasture	49	20
Mine reclamation	36	15
Native grass	12	5
Agriculture[2]	8	3
Mountain shrub	2	1
Nearest cover type		
Sagebrush[1]	68	48
Mountain shrub	62	37
Aspen-shrub	8	6
Native grass	5	4
Grass hay-pasture	3	2
Agriculture	2	1
Conservation Reserve Program	1	<1
Mine reclamation	1	<1
Riparian-cattail marsh	1	<1
Topographic location		
Knoll	45	32
Ridge	44	31
Bench	28	20
Flat	16	11
Slope	8	6
Aspect		
North	38	30
East	26	20
South	16	13
West	25	20
None	22	17
Slope (%)		
0–2	107	76
3–5	28	20
6–9	6	4
≥ 10	0	0

[1]Includes sagebrush-grass and shrubsteppe.
[2]Includes wheat and alfalfa.

shrub cover, taller shrubs, and greater numbers of shrub, forb, and grass species than greater sage-grouse leks did (Klott and Lindzey 1989). In addition, CSTG leks were typically at higher elevations and situated at the edge more so than in the middle of openings compared to greater sage-grouse leks. Visibility, as measured with a cover board (Jones 1968), was greater at sage- and sharp-tailed grouse leks than at random sites, with visibility being greatest at sage-grouse leks.

The amount of cover on the lek appears to be a trade-off between high visibility desirable for breeding and displaying, and lower visibility that enhances security (Klott and Lindzey 1989). Ward (1984) found that male CSTG used the more open areas of their territories on the lek when females were present, but they stayed in areas of greater cover when females were absent. The females tended to use areas with more cover as they moved across the lek. If shrubs are present on the lek, males will use them as perches and calling posts to increase their own audibility and visibility to females. Males also will perch on shrubs when females are absent. This behavior may improve their ability to detect predators.

The actual cover type at the lek is less important than the growth form. Columbian sharp-tailed grouse leks have been found in native shrub and grassland cover types as well as non-native and artificial cover types, including CRP, mine reclamation, pastureland, wheat fields, alfalfa fields, and grass hay meadows (**Table 7**). Within a particular vegetation type, CSTG select sites for leks that offer high visibility, but visibility may vary substantially among leks in different cover types. For example, a lek in shrubsteppe will likely have higher visual obstruction readings (i.e., lower visibility) than a lek in CRP or native grassland.

Other important features influencing where leks occur include food availability and juxtaposition of suitable escape and loafing cover. In some areas where CSTG breed, much of the landscape is snow covered when males return to the breeding range in spring. Nowhere is this more evident than in portions of Region 2 where elevations at lek sites average 2,171 ± 121 m (median = 2,174 m) in Colorado and 2,814 ± 79 m in Wyoming (Klott and Lindzey 1989, Lassige 2002). Oedekoven (1985) reported that CSTG in south-central Wyoming began courtship displays in mid-April when snow depths were 50 to 100 cm. In this situation, CSTG must rely on shrub communities for food and cover during the early part of the breeding season when the herbaceous vegetation is snow covered or has not started to grow (Boisvert 2002). At this time of year, even the exposed, residual, herbaceous vegetation affords little cover because it has been flattened by winter snow. Therefore, during early spring (late March to late April), availability of shrub-dominated communities near (≤ 400 m) leks is critical for food, escape cover, and loafing cover. Edge density of shrubsteppe was one of four variables consistently associated with lek sites at multiple spatial scales in northwestern Colorado (Lassige 2002). Boisvert (2002) documented substantial use of shrubsteppe cover types in spring by CSTG attending leks in CRP and mine reclamation lands in northwestern Colorado. Shrub-dominated cover types occurred on average 127 m (range = 15–450 m) from the center of the leks monitored by Boisvert (2002). Invariably, when the grouse were disturbed on leks, they flew to the nearest patch of shrubs. Boisvert (2002) concluded that although CRP and mine reclamation lands provided ideal sites for leks, CRP, and to a lesser extent mine reclamation, did not provide adequate cover for concealment when CSTG were not on the leks until later in spring after the herbaceous vegetation started to grow.

Perhaps the single most important factor affecting lek location is the proximity to suitable nesting-brooding rearing cover (Meints et al. 1992). Studies in Region 2 indicate that greater than 80 percent of all females nest and raise their young within 2 km of their lek of capture (Oedekoven 1985, Giesen 1997, Collins 2004, Boisvert et al. 2005). Thus, availability of elevated, sparsely vegetated sites is only relevant if suitable nesting and brood rearing cover occurs nearby. The actual lek site is less important than quality and quantity of cover surrounding the lek.

Nesting habitat

Columbian sharp-tailed grouse are nest habitat generalists and nest in many different cover types (Apa 1998). Specific features of CSTG nest sites vary among studies because of geographic differences in cover types available for nesting, differences in growing conditions, variations in sampling methodology, and timing of measurements in relation to nest initiation. Regardless, nests tend to be in vegetation types that provide dense vertical and horizontal concealment (Meints et al. 1992, Giesen and Connelly 1993, Tirhi 1995). The composition and condition (live or dead) of the vegetation at the nest are less important than its structure and growth form. For this reason, CSTG have been documented nesting in undisturbed and disturbed (sprayed or burned) native cover types as well as non-native and artificial cover types. Columbian sharp-tailed grouse also show a high degree of flexibility in the proportion of grasses, forbs, and shrubs that comprise suitable nesting cover. They may nest in grasslands, croplands, seeded rangelands, CRP lands, and mine reclamation with little or no shrubs in the plant community, or they may nest in sagebrush-grass, shrubsteppe, and mountain shrub communities with up to 40 percent shrub cover (Hart et al. 1950, Marks and Marks 1987, Meints 1991, Schroeder 1994, Giesen 1997, Apa 1998, McDonald 1998, Boisvert 2002, Collins 2004). The common denominator appears to be the amount of cover provided by the vegetation

whether it is herbaceous, shrubs, or a combination of both. That is, a certain height and density of vegetation is required for nesting regardless of its composition.

Of 127 nest sites found in north-central Utah, 53 percent were in alfalfa, 27 percent in wheat stubble, and only 18 percent in native vegetation (Hart et al. 1950). This was attributed to the general lack of native vegetation across the landscape and its poor condition due to overgrazing. In west-central Idaho, Marks and Marks (1987) found nine nests, all of which were in native cover, including eight in sagebrush cover types and one in mountain shrub. Of the nine nests, eight were beneath sagebrush and one was beneath arrowleaf balsamroot. In eastern Idaho, Meints (1991) reported 17 (74 percent) of 23 nests were located in shrub habitats and six (26 percent) were in non-shrub habitats. Nest cover types used by CSTG (n = 51) in southeastern Idaho were equally distributed between shrub (49 percent) and herbaceous (51 percent) dominated plant communities (Apa 1998). The dominant plant species immediately above the nest included big sagebrush (32 percent), crested wheatgrass (18 percent; *Agropyron cristatum*), rabbitbrush (12 percent; *Ericameria* spp.), lupine (10 percent), and alfalfa (4 percent). In eastern Washington, Schroeder (1994) reported that 40 percent of nests (n = 10) were in the sagebrush-grass cover type, 40 percent in grass-forb communities, and 10 percent in CRP stands. In another eastern Washington study, McDonald (1998) reported 70 percent of 54 nests were in grass-forb cover, 22 percent in CRP, and 7 percent in grass-shrub cover; no nests were found in the sagebrush cover type. Columbian sharp-tailed grouse in eastern Washington primarily nested at the base of a bunchgrass or between two bunchgrasses. Bluebunch wheatgrass and Idaho fescue were the most common bunchgrasses used as nest cover in native habitats, and crested wheatgrass was used in CRP (McDonald 1998).

Giesen (1997) reported finding only one of 12 nests in a cover type other than mountain shrub; this nest was in a hay meadow under a clump of alfalfa. What Giesen (1997) identified as mountain shrub may actually have been shrubsteppe. Vegetation data collected by Giesen (1997) at CSTG use and random sites indicated the absolute density (plants per ha) of shrubs less than 1.0 m in height greatly exceeded that for shrubs greater than 1.0 m in height, with big sagebrush and snowberry having the highest absolute densities. These are characteristics more commonly associated with shrubsteppe than mountain shrub.

The distribution of 61 nests found by Boisvert (2002) was 27 (44 percent) in mine reclamation, 24 (39 percent) in shrubsteppe, six (10 percent) in CRP, three (5 percent) in grass, and one in aspen-shrub. The dominant plant species above the nest included western wheatgrass, big sagebrush, smooth brome, alfalfa, basin wildrye, and mountain snowberry (*Symphoricarpos oreophilus*). Boisvert (2002) reported that only 28 percent of females captured on leks in CRP nested in CRP, whereas 64 percent nested in shrubsteppe. In comparison, 58 percent of the females captured on leks in mine reclamation also nested in this cover type, and 34 percent nested in shrubsteppe.

Collins (2004) located 137 nests of which 99 (72 percent) were in shrubsteppe, 24 (18 percent) in mine reclamation, and 14 (10 percent) in mountain shrub. The primary overhead cover was provided by big sagebrush and rabbitbrush in shrubsteppe and by basin wildrye and alfalfa in mine reclamation. Eighty-seven of 97 (90 percent) nests (includes renests) produced by females captured on leks in shrubsteppe were in this cover type, and 10 (10 percent) were in mountain shrub. Hens captured on leks in mine reclamation primarily (60 percent) nested (n = 40) in mine reclamation, and secondarily in shrubsteppe (30 percent) and mountain shrub (10 percent). The studies by Giesen (1997), Boisvert (2002), and Collins (2004) were all conducted in northwestern Colorado. The few (n = 3) nest sites that have been described for CSTG in Wyoming were in shrubsteppe (Bredehoft 1981, Oedekoven 1985).

Nest depredation is the chief cause of reproductive failure for most prairie grouse species (Schroeder and Baydack 2001). Nest concealment by vegetation is one defense mechanism used by nesting females to reduce the risk of nest predation (Gotmark et al. 1995). Dense cover immediately surrounding the nest provides a strong barrier between the nest and senses (sight and/or smell) of predators. Because grouse nests are often subject to depredation by avian and mammalian predators, horizontal as well as vertical (overhead) cover is critical at the nest site. It is not surprising that nest success of many grouse species, sharp-tailed grouse included, has been positively correlated with greater cover at the nest site than randomly available across the landscape (Meints 1991, Riley et al. 1992, Gregg et al. 1994, McDonald 1998, McKee et al. 1998, Boisvert 2002, Collins 2004, among others).

Studies of CSTG have reported the following cover-related variables as being greater at nest sites than at random sites: grass height (Meints 1991, Schroeder 1994, Boisvert 2002, Collins 2004), grass cover (Apa 1998, McDonald 1998, Boisvert 2002, Collins 2004), visual obstruction (Meints 1991, Schroeder 1994,

McDonald 1998, Boisvert 2002, Collins 2004), litter cover (McDonald 1998), shrub cover (Meints 1991, Giesen 1997, Boisvert 2002), cover board readings (Apa 1998, Boisvert 2002), and residual vegetation (Boisvert 2002). Several of the same studies reported that bare ground, which usually increases with decreasing cover, was less at nest sites than at random sites (Meints 1991, Schroeder 1994, McDonald 1998).

Studies have not only revealed differences in structural characteristics (i.e., height and density of vegetation) of nest sites compared to random sites, but also of nest sites compared to sites within 20 m of the nest. Boisvert (2002) reported that percent residual cover and percent grass cover were higher at the nest bowl than at sites 5, 10, and 20 m from the nest. Collins (2004) also found that percent grass cover was greater, and percent bare ground was less, at the nest bowl than at sites 2.5, 5, and 10 m away. Data collected by McDonald (1998) indicated that percent bare ground increased, and percent litter cover and visual obstruction readings both decreased at increasing distances from the nest bowl. In the Curlew Valley, Idaho, CSTG that nested under sagebrush selected plants that were taller (89 versus 67 cm) and larger in circumference (9,583 versus 4,318 cm^2) than plants within a 20 m radius of the nest (Apa 1998).

Optimum nest sites in eastern Washington had visual obstruction readings of 2.79 dm, 54.2 percent grass cover, 82.8 percent litter cover, 5.6 percent bare ground, and 84 percent overhead canopy cover (McDonald 1998). Boisvert (2002) reported that CSTG nest sites in northwestern Colorado consistently had higher mean canopy cover of residual vegetation (≥ 8.5 percent) and grass (≥ 31.9 percent), and greater visual obstruction (≥ 48.8 cm) and overstory cover (≥ 62.8 percent) than at random sites (**Table 8**). Collins (2004) recommended that nesting areas in shrubsteppe should contain the following minimum characteristics: grass cover greater than 22 percent, grass height greater than 22 cm, bare ground less than 4 percent, and visual obstruction at 2.5 m greater than 48 cm (**Table 8**). For mine reclamation, Collins (2004) recommended grass cover greater than 60 percent, grass height greater than 62 cm, bare ground less than 3 percent, and visual obstruction at 2.5 m greater than 46 cm.

Table 8. Topographic and vegetation characteristics (mean values) at Columbian sharp-tailed grouse nest sites in USDA Forest Service Rocky Mountain Region (Boisvert 2002, Collins 2004). Sample sizes are in parentheses.

	Boisvert (2002) All cover types		Collins (2004) Mine reclamation		Collins (2004) Shrubsteppe	
Characteristic	**1999(28)[1]**	**2000(33)[1]**	**2001(16)[1]**	**2002(16)[1]**	**2001(35)[1]**	**2002(24)[1]**
Coverboard, %[2]	59.6	62.4	73.6	83.6	70.8	58.8
Residual cover, %	8.5	14.0	—	—	—	—
Litter cover, %	79.1	78.6	88.3	89.5	70.2	86.4
Bare ground, %	10.6	6.1	5.3	7.9	9.2	11.4
Shrub cover, %	9.7	23.9	1.8	1.8	39.9	38.5
Grass cover, %	43.6	31.9	41.9	45.5	15.5	19.3
Forb cover, %	24.3	21.9	26.1	17.4	17.4	16.5
VOR, cm[3]	29.9	33.3	57.3	53.1	70.6	64.4
Shrub height, cm	29.6	49.4	41.0	35.8	61.5	60.1
Grass height, cm	68.0	93.5	57.1	56.7	21.9	12.1
Species richness[4]	13	16	19	15	27	23
Slope, °	5	6	8.0	9.6	5.6	5.9
Elevation, m	2210	2181	2130	2149	2182	2211
Nearest edge, m	109	98				

[1]Moderate drought conditions occurred in 2000 and 2001, and extreme drought conditions occurred in 2002. Normal conditions occurred in 1999.
[2]Viewed from a height of 1.5 m and expressed as the percentage of 3x3 cm squares of 25 total squares covered by ≥ 50 percent vegetation (Jones 1968).
[3]Visual obstruction (vertical cover) measured with a 2-m cover pole read from a height of 1.5 m and distance of 10 m (Griffith and Youtie 1988). Expressed as the height at which the pole is covered by ≥ 25 percent vegetation.
[4]Total species recorded.

Microhabitat characteristics that distinguish successful from unsuccessful nest sites include the same variables that separate nests from random sites. Generally, successful nest sites provide more cover than unsuccessful nest sites do. In eastern Washington, percent bare ground was less and percent litter cover and visual obstruction were greater at successful than unsuccessful nests; grass cover and canopy cover directly above the nest bowl also were greater at successful than unsuccessful nests (McDonald 1998). Meints (1991) found that in eastern Idaho, successful nests were in sites with taller grass (26.8 ± 8.7 versus 18.4 ± 2.0 cm) and a greater mean density of shrubs greater than 20 cm in height (1.0 ± 0.3 versus 0.8 ± 0.3 shrubs per m^2) compared to unsuccessful nest sites.

Boisvert (2002) and Collins (2004) measured attributes of successful and unsuccessful nests in mine reclamation and native shrubsteppe. Boisvert (2002) reported that visual obstruction 1 m from the nest bowl was the most significant variable contributing to differences between successful and unsuccessful nests in mine reclamation (38 versus 23 cm) and shrubsteppe (38 versus 30 cm). Collins (2004) reported that grass height at the nest and 1 m from the nest were significant predictors of nest success in both mine reclamation and shrubsteppe. Mean grass height at the nest was 62.1 and 20.8 cm at successful nests in mine reclamation and shrubsteppe, respectively. The corresponding measurements at unsuccessful nests were 38.8 cm in mine reclamation and 16.8 cm in shrubsteppe. Measurements 1 m from the nest bowl were 37.5 cm for successful nests and 20.9 cm for unsuccessful nest in mine reclamation. In shrubsteppe, measurements 1 m from the nest were 21.5 cm for successful nests and 17.0 cm for unsuccessful nests. Collins (2004) also reported that visual obstruction at the nest bowl recorded from 2.5 and 10 m away was higher at successful (46.2 cm at 2.5 m and 59.1 cm at 10 m) than unsuccessful nests (31.1 cm at 2.5 m and 40.9 cm at 10 m) in mine reclamation. Visual obstruction did not differ between successful and unsuccessful nests in shrubsteppe.

Several studies have shown that macrohabitat features, such as slope, aspect, elevation, distance to nearest other cover type, and distance to nearest man-made structure, rarely differ between nest and random sites and are not as important in the selection of nest sites as microhabitat features (Apa 1998, Boisvert 2002, Collins 2004). However, there is compelling evidence to suggest that CSTG select nest sites on gentle to moderate slopes more so than steeper slopes. Average slopes at nest sites in northwestern Colorado were reported as 5° (range = 0–10°, n = 28) and 6° (range = 1–16°, n = 33) by Boisvert (2002), and as 8.0 ± 4.5° (n = 16), 5.6 ± 5.6° (n = 35), 9.6 ± 4.1° (n = 20), and 5.9 ± 2.8° (n = 36) by Collins (2004). In southeastern Idaho, 44 (86 percent) of 51 CSTG nests were on slopes less than 9 percent, and seven (14 percent) were on slopes between 10 and 19 percent (Apa 1998). The slope at 10 nest sites in eastern Washington averaged 1.7 ± 1.6 percent (Schroeder 1994).

Measurements of microhabitat characteristics at nest sites are typically made after females have completed nesting or abandoned the nest. This is done to avoid disturbing the female during egg laying and incubation. These measurements do not consider plant growth and/or senescence and may not accurately reflect the microhabitat conditions selected by the female at time of nest initiation (Hausleitner et al. 2005). Sharp-tailed grouse may select nest sites before visiting leks to breed (Gratson 1988). Thus, the period between when the female selects the nest site and when site characteristics are measured may exceed 40 days. Collins (2004) attempted to address this problem by comparing microhabitat characteristics at the approximate time of nest initiation and at time of hatch.

In 2001, Collins (2004) measured nest site characteristics at 24 successful nests immediately after the females left the nests. In 2002, Collins (2004) re-measured the same 24 nest sites at the approximate time the females selected the sites in 2001. This approach avoided the need to flush the females from the nests, but it had the disadvantage of measuring the sites the following year potentially under different growing conditions. The data indicated that several variables increased from time of nest initiation to hatch, the most notable of which were grass height at the nest and 1 m from the nest. In mine reclamation, grass height at the nest and 1 m from the nest increased from 46.4 to 67.0 cm (44 percent increase) and 20.1 to 41.2 cm (63 percent increase), respectively. In shrubsteppe, grass height at the nest increased 47 percent from 14.3 to 21.0 cm, and grass height 1 m from the nest increased 72 percent from 11.6 to 20.0 cm. This suggests the minimum grass height for suitable nesting cover may be substantially less than measured at time of hatch.

Summer and brood-rearing habitat

Columbian sharp-tailed grouse select brood habitats based on structure and composition of the vegetation (Giesen and Connelly 1993). Brood habitats must be structured so that chicks can travel easily through the vegetation, while simultaneously

providing adequate cover for protection from predators and adverse weather (Bergerud and Gratson 1988). In addition, brood habitats must support the plant species that meet the nutritional requirements of both the female and her chicks (Bergerud and Gratson 1988). Cover types that meet these criteria can vary from native grasslands and CRP with little or no shrub cover to shrubsteppe and mountain shrub communities with greater than 40 percent shrub cover. For any cover type to be suitable for brood-rearing, it must support an abundance of forbs (Hart et al. 1950, Klott and Lindzey 1990, Meints 1991, Apa 1998, Boisvert 2002, Collins 2004). Forbs are consumed by the female and by chicks as they grow. More importantly, forbs attract insects, and insects comprise over 80 percent of the chick's diet during the first two to three weeks of life (Hart et al. 1950, Jones 1966, Bernhoff 1969).

Ideally, suitable brood-rearing areas should be interspersed with suitable nesting areas to minimize the distance females must move after leaving the nest with their chicks. On native ranges, quality brood habitats can best be described as a mosaic of shrubsteppe and grassland communities that support a diversity of forbs and grasses (Giesen and Connelly 1993). Broods use grasslands for foraging in the morning and evening and retreat to shrub cover during mid-day. Within grassland communities, bunchgrasses are considered better than sod-forming grasses because they allow for easier movement through the understory. Furthermore, if left undisturbed, sod-forming grasses tend to become stunted and grow in dense mats that exclude many forbs, thus, providing poor brood habitat (Monsen 2005).

High interspersion of cover types is considered an important feature of CSTG brood habitat (Giesen and Connelly 1993, Connelly et al. 1998), presumably because of the greater "edge effect." However, there is conflicting evidence regarding the use of habitat edges by broods. In southeastern Idaho, McArdle (1977) reported that greater than 70 percent of his brood observations were 30 m or less from the nearest habitat edge. Meints (1991) reported a median distance of 50 m to the nearest other habitat for CSTG broods in eastern Idaho. In south-central Wyoming, Klott and Lindzey (1990) noted that when broods used large openings, they foraged on the edges and avoided the centers. In contrast to these studies, Boisvert (2002) found no difference in distance to habitat edge between brood and random sites for broods primarily using mine reclamation and CRP. In Boisvert's (2002) study, distance to habitat edges averaged 70 m and was highly variable (range = 1–675 m). Collins (2004) also found that use of habitat edges by broods in mine reclamation was highly variable and on average (2000: mean = 289 ± 259 m; 2001 mean = 188 ± 200 m) greatly exceed distances reported by other investigators, including Boisvert (2002). Boisvert (2002) suggested that interspersion of cover types may be of greater importance for broods using native cover types than those using mine reclamation and CRP. Grasses are the dominant vegetation in CRP and mine reclamation, and shrubs are often rare or completely absent. In this situation, protection from predators may be enhanced if the broods become "lost in a sea of grass" rather than remain near habitat edges.

High diversity of grasses and forbs is another feature often reported as an essential component of CSTG brood habitat (Giesen and Connelly 1993, Connelly et al. 1998). While this may be true for native cover types, it may not apply to artificial cover types, such as CRP, depending on what is planted in the fields. Sharp-tailed grouse broods are known to use CRP fields where greater than 95 percent of the vegetation consists of only two to five species of grasses and forbs (Sirotnak et al. 1991, Apa 1998, McDonald 1998, Boisvert 2002, Utah Division of Wildlife Resources 2002, Rodgers and Hoffman 2005). Rodgers and Hoffman (2005) reported that fields ranging in height from 30 to 75 cm and containing a large component of alfalfa in combination with two to three species of bunchgrasses appear to be of greatest benefit to sharp-tailed grouse. In southeastern Idaho, CSTG broods extensively used fields consisting primarily of alfalfa and crested wheatgrass; forbs (mainly alfalfa) comprised nearly 40 percent of the fields (Sirotnak et al. 1991). In northern Utah, CRP lands seeded with alfalfa, tall wheatgrass (*Thinopyrum ponticum*), intermediate wheatgrass, and basin wildrye have provided valuable nesting and brood-rearing areas for CSTG (Utah Division of Wildlife Resources 2002, Rodgers and Hoffman 2005). Female CSTG transplanted to southwestern Colorado nested and raised their broods almost exclusively in CRP fields containing mostly alfalfa, tall wheatgrass, and crested wheatgrass (Colorado Division of Wildlife, unpublished data). Other forbs that frequently invade CRP fields and provide additional benefits to sharp-tailed grouse primarily as food included prickly lettuce, yellow salsify, and common dandelion.

Within Region 2, Boisvert (2002) measured macro- and microhabitat characteristics at 99 brood and 99 random sites in northwestern Colorado (**Table 9**). The distribution of brood locations by cover type was as follows: 67 percent mine reclamation, 19 percent shrubsteppe, 6 percent grasslands, 4 percent CRP, 3 percent mountain shrub, and 1 percent aspen. No differences were detected in slope, aspect, elevation,

Table 9. Topographic and vegetation characteristics (mean values) at Columbian sharp-tailed grouse brood sites in USDA Forest Service Rocky Mountain Region (Klott 1987[1], Boisvert 2002[2], and Collins 2004[3]).

		Boisvert (2002)		Collins (2004) MR		Collins (2004) SS	
Characteristic	**Klott (1987)**	**1999**	**2000**	**2001**	**2002**	**2001**	**2002**
Forb cover, %	28.8	32.9	21.8	24.0	26.7	15.0	11.0
Grass cover, %	32.6	36.1	25.9	17.4	28.9	17.4	15.8
Shrub cover, %	27.8	3.6	17.1	2.3	2.3	28.1	59.8
Litter cover, %	27.7	79.7	76.6	87.7	83.1	76.0	78.8
Bare ground, %	10.2	12.0	7.0	10.3	14.6	14.9	17.8
Species richness[4]	26	10	12	26	17	26	19
Shrub ht., cm	—	94.2	93.0	45.5	34.6	61.8	117.6
Grass ht., cm	—	84.7	64.6	37.7	37.9	24.9	24.7
Forb ht., cm	—	58.3	45.2	22.2	24.9	11.2	15.4
VOR, cm[5]	—	49.9	54.3	41.9	61.8	64.1	104.9
Slope, °	—	7	7	8.9	10.7	5.2	9.0
Elevation, m	—	2232	2205	2287	2168	2224	2270
Nearest edge, m	—	147	71				

[1]Combined data for 44 broods observed in 1985 and 1986 primarily in shrubsteppe and mountain shrub cover types.
[2]Data reported separately for 1999 (n = 48) and 2000 (n = 51, moderate drought year); 92 percent of broods observed in mine reclamation or shrubsteppe.
[3]Data reported separately by cover type (MR = mine reclamation, SS = shrubsteppe) for 2001 (n = 14 for MR and 22 for SS, moderate drought year) and 2002 (n = 16 for MR and 24 for SS, extreme drought year).
[4]Total species recorded.
[5]Visual obstruction (vertical cover) measured with a 2-m cover pole read from a height of 1.5 m and distance of 10 m (Griffith and Youtie 1988). Expressed as the height at which the pole is covered by ≥ 25 percent vegetation.

distance to edge, or distance to nearest road between brood and random locations. Several microhabitat variables differed between years due to differences in growing conditions; however, within years, brood sites consistently had higher mean visual obstruction readings, greater forb cover, and greater overstory cover than random sites. Boisvert (2002) further reported that unlike nest site characteristics, which were highly specific at the nest bowl compared to the immediate surroundings, brood site characteristics were more uniform across a larger area. This reflects the need of the female and her brood to move to obtain adequate resources. Alfalfa, cicer milkvetch (*Astragalus cicer*), common dandelion, asters (*Aster* spp.), maiden blue eyed mary (*Collinsia parviflora*), and American vetch (*Vicia americana*) were some of the most common forbs identified by Boisvert (2002) at brood sites. In summary, Boisvert (2002) found that females with broods used areas with greater than 20 percent forb cover that provided consistently high visual obstruction (≥ 50 cm) and canopy cover, (≥ 70 percent) mainly in the form of herbaceous (grasses and forbs) vegetation and secondarily by shrubs such as big sagebrush and snowberry.

Collins (2004) measured macro- and microhabitat characteristics at 76 brood and 79 random sites in mine reclamation and shrubsteppe in northwestern Colorado (**Table 9**). Some variables differed between years, but within years, broods in both cover types consistently used sites with greater forb cover and taller forbs than randomly available across the landscape. Grass and forb cover, and grass and forb heights were greater at mine reclamation brood sites than shrubsteppe brood sites, whereas shrub cover (big sagebrush, snowberry, serviceberry, and rabbitbrush) was greater at shrubsteppe brood sites. Forbs frequently identified at brood sites included yellow salsify, alfalfa, arrowleaf balsamroot, common dandelion, and cicer milkvetch. Collins (2004) failed to find any differences in overstory cover or visual obstruction between brood and random sites as noted by Boisvert (2002).

Of 44 broods observed in south-central Wyoming, 73 percent were in sagebrush-snowberry or mountain shrub cover types where the total shrub cover averaged 27.8 ± 13.5 percent (**Table 9**; Klott 1987, Klott and Lindzey 1990). Within these cover types, broods used sites where shrub cover and height were less

than average for the cover type. Forb cover averaged 29 percent, with sulphur buckwheat (*Eriogonum umbellatum*) usually present. Grass cover averaged 33 percent, with bulbous oniongrass (*Melica bulbosa*), bluegrasses, wheatgrasses, and needlegrasses (*Stipa* spp.) often present.

Females without chicks and males use the same cover types during summer as females with chicks. The only difference between brood and male locations in eastern Idaho was that broods used areas with taller grass (Meints 1991). In northwestern Colorado, Boisvert (2002) reported that forb cover was the only variable that differed between brood sites (1999 = 32.2 percent, 2000 = 21.8 percent) and sites used by males and females without chicks (1999 = 24.1 percent, 2000 = 11.7 percent). Giesen (1997) reported that although males and females were located most often in mountain shrub, males used hay meadows more often than expected based on availability. This selection was strongest from June to August. Females generally avoided all cover types other than native mountain shrub. Giesen (1997) made no distinction between habitat use data collected for females with and without chicks. What Giesen (1997) referred to as mountain shrub was more likely shrubsteppe.

Of 716 summer (May to September) flush sites of 15 radio-marked grouse (13 males, two females without chicks) in western Idaho, 83 percent were in big and low sagebrush (*Artemisia arbusula*) cover types (Saab and Marks 1992). Grouse avoided intermediate wheatgrass and eriogonum cover types and only used dense riparian and mountain shrub cover types as escape cover. Compared to random sites within the two sagebrush cover types, grouse selected areas with (1) greater horizontal and vertical cover, (2) greater canopy cover of forbs typically decreased by livestock grazing, (3) greater density and canopy cover of arrowleaf balsamroot, and (4) greater canopy coverage of bluebunch wheatgrass. Arrowleaf balsamroot and bluebunch wheatgrass are native perennials, and both are decreaser species (Blaisdell and Pechanec 1949). Based on these findings, Saab and Marks (1992) concluded that CSTG were selecting areas least modified by livestock grazing. They found no evidence that CSTG sought free water during summer. Mean distance to water was 297 ± 183 m and did not differ from random sites. Parker (1970) and Klott (1987) similarly concluded that CSTG did not seek free water.

Fall habitat

Columbian sharp-tailed grouse continue to use the same habitats during fall that they occupied throughout the summer (Giesen 1997, Boisvert 2002). They remain on summer use areas until the snow accumulates and causes them to move to wintering areas. Males start spending more time on and near the leks as fall approaches. Because of their attraction to the leks, males tend to remain on the summer range longer than females do. During the day, CSTG may move to patches of serviceberry and chokecherry to feed on ripening fruits. Although wheat fields occur throughout the range of CSTG, use of wheat varies locally and regionally. Giesen (1997) documented some use of wheat fields in northwestern Colorado during fall immediately after grain harvest. Hoffman (1980) also reported observing CSTG using wheat fields in northwestern Colorado during fall. Dargan et al. (1942) and Rogers (1969) both considered wheat fields an important component of CSTG habitats in northwestern Colorado. Contrary to these reports, Boisvert (2002) and Collins (2004) documented no use of agricultural lands by CSTG during any time of year on their study areas in northwestern Colorado.

Winter habitat

The onset of winter generally causes a marked shift in habitat use patterns of CSTG (Giesen and Connelly 1993, Connelly et al. 1998). Cover types most frequently used by CSTG during winter include mountain shrub, riparian, and aspen (Hart et al. 1950, Parker 1970, Hofmann and Dobler 1988b, Marks and Marks 1988, Meints 1991, Ulliman 1995b, McDonald 1998, Boisvert 2002). The shrub component within these cover types often averages over 1 m in height and includes at least one or two of the following species: serviceberry, chokecherry, willow, hawthorn, and birch.

Columbian sharp-tailed grouse also have been reported using CRP fields, open juniper woodlands, Russian olive (*Elaeagnus angustifolia*) stands, and wheat fields during winter (Marks and Marks 1988, Meints 1991, Sirotnak et al. 1991, Ulliman 1995b, McDonald 1998). Use of predominantly herbaceous cover types, such as CRP and wheat, and low (<1 m) shrub types during winter is a function of snow depths. As snow accumulates, CSTG abandon these cover

types in favor of mountain shrub and riparian areas that support tall shrubs that protrude above the surface of the snow. Giesen and Connelly (1993) considered the presence of mountain shrub or riparian shrub communities essential for the long-term persistence of CSTG populations.

Marks and Marks (1988) documented 108 winter locations of CSTG in western Idaho, of which 35 were in mountain shrub, 28 in big sagebrush, 25 in riparian areas, 18 at seeps, and two in unclassified cover types. They reported that 88 percent of their winter observations were within or near (≤ 50 m) mountain shrub or riparian cover types. The principal species in the mountain shrub type were serviceberry and chokecherry while hawthorn was the dominant species in riparian areas used by CSTG. Use of cover types differed among winters. Forty-two percent of 52 winter locations during 1983–84 occurred in the riparian hawthorn cover type compared to only 5 percent of 56 locations in this cover type over the following two winters. Variations in cover types used within and among winters were attributed to changes in food availability and snow conditions.

On one study area in eastern Idaho, Meints (1991) reported that large (≥ 200 grouse) winter concentrations of CSTG fed in grain fields during the morning and returned to aspen and mountain shrub patches during the day. On another nearby study area, winter use was limited to chokecherry patches and stands of Utah juniper (*Juniperus osteosperma*). McArdle (1977) reported that winter use by CSTG in southeastern Idaho was confined to areas with greater than 40 percent shrub cover. Ulliman (1995b) found major differences in habitat use patterns of radio-marked grouse from one winter to the next in southeastern Idaho. During the mild winter of 1992, radio-marked grouse used CRP fields and remnant sagebrush patches within the CRP fields. During the more severe winter of 1993, grouse primarily used riparian and mountain shrub cover types although some birds remained in the sagebrush type near patches of Russian olive (Ulliman 1995b). Compared to random sites, grouse use sites had more alfalfa and yellow salsify in 1992, and more serviceberry in 1993.

In eastern Washington, Hofmann and Dobler (1988b) observed 117 CSTG during winter. These grouse used several cover types but were primarily in big sagebrush (34 percent), riparian areas (26 percent), and wheat fields (17 percent). Riparian stringers with water birch were identified as critical winter habitat. As snow depths increased, so did use of riparian areas. During winter in eastern Washington, McDonald (1998) also observed CSTG using a diversity of cover types, including CRP, grass-forb, grass-shrub, big sagebrush, riparian/mountain shrub, and wheat. Use depended upon snow cover, with use of shrub-dominated cover types (i.e., sagebrush and riparian/mountain shrub) increasing as snow depths increased. Two cover types, riparian/mountain shrub and wheat, were used solely during winter. McDonald (1998) reported that use of the riparian/mountain shrub cover type was likely under-represented and sagebrush over-represented in his study. Grouse were often found later in the day when they were roosting in the sagebrush cover type, but inspection of their droppings indicated they had been feeding almost exclusively on water birch along nearby riparian stringers.

Clearly, CSTG can exploit a variety of habitats during winter, but most use is confined to one or two cover types due to snow depths. This is particularly true in Region 2 where CSTG occur at higher elevations than elsewhere throughout the subspecies' range. Within Region 2, Boisvert (2002) documented no use of CRP, mine reclamation, native grasslands, agricultural lands, or riparian corridors during winter and only limited use of shrubsteppe. The primary cover type used by CSTG during winter was mountain shrub (**Figure 6**; 58 percent of locations) followed by aspen (22 percent). The aspen stands used by sharp-tailed grouse during winter supported a relatively dense understory of mountain shrubs (Boisvert 2002). Grouse were seldom observed in aspen stands with predominantly herbaceous understories unless they were flushed into the trees from nearby mountain shrub patches. Use of shrubsteppe (20 percent of locations) was confined to south slopes, and stands of mountain shrub generally occurred nearby (≤ 100 m). Serviceberry was the single most common shrub found at CSTG winter locations (**Figure 6**). Topographically, areas used by CSTG during winter were at higher elevations (2,202 to 2,593 m) than breeding-summering areas (2,076 to 2,280 m) and tended to be on north slopes with deep, soft snow suitable for roosting (Boisvert et al. 2005).

Similar to Boisvert (2002), Collins (2004) documented no use of CRP, mine reclamation, agricultural lands, or riparian corridors, some use of shrubsteppe, and extensive use of mountain shrub by CSTG during winter in northwestern Colorado. Unlike Boisvert (2002), Collins (2004) observed occasional use of open Rocky Mountain juniper (*Juniperus scopulorum*) woodlands interspersed with shrubsteppe and patches of mountain shrub. From December through late March in Wyoming, Oedekoven (1985) observed CSTG primarily in serviceberry-aspen, cottonwood-willow riparian, hawthorn riparian, serviceberry-chokecherry,

Figure 6. Columbian sharp-tailed grouse winter habitat in USDA Forest Service Rocky Mountain Region primarily consists of mountain shrub communities dominated or co-dominated by serviceberry. Photograph by Richard W. Hoffman.

and sagebrush-mixed shrub. Oedekoven (1985) stressed the importance of woody cover in collecting snow and creating conditions suitable for snow roosting, which he believed was critical to the winter survival of CSTG in south-central Wyoming.

Landscape configuration and size

Several studies have emphasized the importance of nesting and brood-rearing habitats while others have shown the necessity of winter foraging and roosting habitats. Although individually all of these habitats are critical, it is their quality, quantity, inter-relatedness, and configuration across the landscape that are crucial for supporting healthy populations of CSTG (Giesen and Connelly 1993, Tirhi 1995, Hoffman 2001). The Northwest Colorado Columbian Sharp-tailed Grouse Conservation Plan recommends maintaining 20 percent of the landscape in deciduous shrub-dominated communities, 20 percent in sagebrush-dominated communities, 15 percent in grasslands, 5 percent in aspen, and 5 to 10 percent in CRP and mine reclamation (Hoffman 2001). These types must be well distributed across the landscape. Ideally, for each lek site, suitable escape cover should occur within 400 m, suitable nesting and brood-rearing cover within 2.0 and preferably 1.0 km, and suitable winter habitat within 4 km and no more than 6.5 km. Within a 2.0 km radius of the lek, a minimum of 50 percent of the area should be suitable for nesting and brood-rearing. Within 6.5 km, at least 10 percent of the landscape should consist of suitable winter habitat.

The minimum amount of area required to support a self-sustaining population of CSTG is unknown and highly dependent on the quality and juxtaposition of suitable breeding, nesting, brood-rearing, and wintering areas. Bart (2000) reported that no known populations of CSTG persist on areas less than 50 km^2 in size. Connelly et al. (1998) recommended 30 km^2 as the minimum area necessary for a successful reintroduction, provided at least 33 percent of the landscape consists of undisturbed grass-shrub cover. A population viability analysis conducted on prairie sharp-tailed grouse in Wisconsin indicated a spring population of 280 birds on 4,000 ha would be the minimum necessary to insure the population persisted for at least 50 years (Temple 1992). Assuming a 1:1 sex ratio and an average lek size of 16 males, this equates to nine total leks or one lek every 4.4 km^2. No data sets that span sufficient years are available to conduct a meaningful population viability analysis for any population of CSTG.

Population connectivity

At one time populations of CSTG were scattered throughout western Colorado (Rogers 1969, Giesen and Braun 1993). Corridors of suitable habitats probably allowed for some movement between populations (Rogers 1969). Presently, one contiguous population of CSTG exists in Region 2 in northwestern Colorado and south-central Wyoming (Hoffman 2001). There are no obvious barriers impeding movements within this metapopulation. An effort is underway to establish another population in southwestern Colorado. If the transplant is successful, the newly established population will be separated from the larger metapopulation by over 300 km. Other potentially suitable transplant sites (i.e., north and south ends of the Uncompahgre Plateau, Cerro Summit, Pinõn Mesa) occur in between, but large tracts of mostly unsuitable habitat make it unrealistic to link the transplanted population in southwestern Colorado with the established population in northwestern Colorado. For the same reason, it is equally unrealistic to attempt to link populations in Region 2 with the nearest other populations in Utah and Idaho. However, it may be possible to link occupied habitats in northwestern Colorado with potentially suitable but unoccupied habitats nearby (<40 km) in Middle Park and North Park. It also may be possible to expand the population in northwestern Colorado southward into Rio Blanco and Garfield counties and further to the west in Moffat County. Conceivably, it also may be possible to establish and link populations in southwestern Colorado. For example, if populations are established on the north end on the Uncompahgre Plateau and on Pinõn Mesa, then these two areas are only separated by Unaweep Canyon, and interchange between the two populations would be possible. Expansion of the population in south-central Wyoming is unlikely, but opportunities may exist to establish new populations in southwestern and west-central Wyoming and link these populations with established populations in northern Utah and eastern and southeastern Idaho.

Although the population in northwestern Colorado has increased, there is no evidence to suggest that it has expanded its range (Hoffman 2001). This is in contrast to populations in Utah where wildlife officials estimate the distribution has increased approximately 400 percent in response to the implementation of the Conservation Reserve Program (Utah Division of Wildlife Resources 2002). Columbian sharp-tailed grouse in northwestern Colorado are known to move over 40 km between breeding and wintering areas (Collins 2004, Boisvert et al. 2005), but these long movements have not resulted in expansion of the population. For instance, CSTG breeding in Moffat County frequently move south to suitable wintering areas in Rio Blanco County (Collins 2004). However, suitable breeding habitats in Rio Blanco County remain mostly unoccupied; to date, only one active lek has been located in Rio Blanco County. Trapping and moving grouse from Routt and eastern Moffat counties to unoccupied habitats in Rio Blanco, Garfield, and western Moffat counties may not be a viable option because birds released may return to where they were captured. It may be necessary to obtain birds from populations outside of Colorado to successfully expand the range of CSTG in northwestern Colorado.

Nutritional ecology

Feeding behavior

Columbian sharp-tailed grouse may feed anytime throughout the day, but intense feeding bouts occur at dawn and dusk. Under severe winter weather, CSTG may only feed once during the day. Food is stored in a well-developed crop for later digestion. Sharp-tailed grouse, like most other grouse species, have a large muscular gizzard for grinding food. The gizzard is especially important in grinding coarse foods that comprise the bulk of the winter diet. From April through October, most feeding is from the ground, but birds may fly into and perch in trees and shrubs to feed on buds, leaves, and fruits. During the winter, especially in Region 2, most feeding occurs in shrubs and at times in trees. When not feeding, the grouse are on the ground where they roost on the surface or beneath the snow.

Food habits

The food habits of CSTG are poorly documented (Giesen and Connelly 1993). Much of what is known is based on analyses of droppings (Marshall and Jensen 1937, Hart et al. 1950, Jones 1966), which may underestimate the importance of highly digestible foods. Ulliman (1995b) suggested that at the macro-level, the food habits of CSTG appear to be similar to those of plains and prairie sharp-tailed grouse for which substantially more information has been published (Aldous 1943, Grange 1948, Edminster 1954, Kobriger 1965, Hillman and Jackson 1973, Evans and Dietz 1974, Sisson 1976, Thomas 1984, Mitchell and Riegert 1994). Sharp-tailed grouse are primarily vegetarians throughout the year with the exception of young chicks (Connelly et al. 1998). Composition of the diet varies regionally and locally from one year to the next depending on food availability. While CSTG consume a wide array of plants and insects, the bulk of the diet

often consists of only three or four different items at any one time.

Throughout much of its range, and particularly in Region 2, food habits of CSTG differ markedly between winter and other seasons of the year. During winter, the diet primarily consists of buds, persistent fruits, and cultivated grains (where available) and gradually shifts to forbs in spring as the snow melts. By mid- to late spring, the diet consists of forbs and grasses. Forbs continue to be the main item in the diet throughout the summer along with insects, fruits, and seeds as they become available. Insects are critically important in the diet of chicks during the first three to four weeks of life. Consumption of insects by young plains sharp-tailed grouse in Nebraska accounted for 92 percent of their diet during the first three weeks of age, 63 percent at seven weeks, and 9 percent at 12 weeks (Kobriger 1965). Forbs, insects, seeds, fruits, and cultivated grains are all foods that may be consumed during fall. The actual proportion of the diet comprised of these items will vary locally and regionally depending on availability. Usually by late fall or early winter, sufficient snow has accumulated to force the birds to shift to a diet of buds and persistent fruits. During mild winters, sharp-tailed grouse may supplement their winter diet of buds with grasses and forbs.

Marshall and Jensen (1937) made one of the earliest attempts to identify the foods of CSTG in the Cache Valley in northern Utah. Their study was conducted from October through May and was based on analyses of droppings, field observations of actual feeding, and interpretation of tracks and other sign on the snow. They observed that CSTG do not scratch or dig for food and only feed on foods on or above the surface of the ground or snow. Their findings clearly reflected a marked correlation between the foods eaten and changing snow depths. Food items consumed during fall (October and November) included wheat, sunflower, and grass seed heads. From December through February, CSTG ate foods that protruded above the snow, such as buds of chokecherry and maple, and seed heads of sagebrush and sunflowers. If snow conditions permitted, they also consumed wheat and green grass blades. As the snow melted in spring (March through May), wheat, green grass blades, alfalfa, and insects became increasingly important foods. The food habits of CSTG in this region were a reflection of habitat conditions. Much of the native habitat had been converted to agriculture. The remaining patches of native vegetation were degraded due to overgrazing and provided little in the way of food. The primary food items during spring and fall were obtained from agricultural lands.

Hart et al. (1950) summarized and expanded upon the work conducted by several investigators on CSTG in the Cache Valley, including the study by Marshall and Jensen (1937). They reported the monthly rank of principal foods consumed by CSTG as ascertained by combining the food habits data collected over 15 years of study from field observations and examination of dropping, crop, and stomach contents (**Table 10**). In contrast to Marshall and Jensen (1937), Hart et al. (1950) reported more serviceberry and knotweed and no maple in the winter diet, and the presence of rose (*Rosa* spp.) hips in the fall diet. Hart et al. (1950) also identified summer (June through September) foods of CSTG, which Marshall and Jensen (1937) did not report. Neither Marshall and Jensen (1937) nor Hart et al. (1950) made any distinction between foods eaten by males and females. Hart et al. (1950) does mention that the diet of juvenile grouse during the first two to three weeks of life consisted of 80 to 100 percent insect material, with plant material appearing in the diet at four to five days of age.

Marshall and Jensen (1937) and Hart et al. (1950) may have misinterpreted some field observations of grouse feeding. Both reported use of mule-ears (*Wyethia* spp.) and sagebrush leaves and seeds. While use of sagebrush seeds is likely, consumption of sagebrush leaves and mule-ears is questionable. It may have appeared that grouse were eating the plant material, but it is more likely they were gleaning insects from the plants.

Green plant material represented 96 percent of the total volume of foods eaten by CSTG in eastern Washington during spring and summer, with Sandberg's bluegrass, early buttercup (*Ranunculus glaberrimus*), and common dandelion the most frequently identified food items (Jones 1966). Fall foods consisted primarily (68 percent) of plant material and secondarily of insects (32 percent). The most frequently identified fall foods were common dandelion, grasshoppers, and grass leaves.

Parker (1970) examined 149 crops from CSTG collected during summer (n = 49) and fall (n = 100) in southeastern Idaho (**Table 11**). Over 50 different items were identified, but three or four items consistently comprised more than 80 percent of the total dry weight of the crop contents. Juveniles consumed more insects than adults did during summer. Consumption

Table 10. Relative monthly rank of principal foods of Columbian sharp-tailed grouse in northern Utah based on observations and analyses of dropping, stomach, and crop contents (from Hart et al. 1950).

Month	Foods consumed (in order of probable importance)
January	Chokecherry buds
	Serviceberry buds
	Knotweed seeds
	Grass seeds and leaves
	Wheat seeds
February	Chokecherry buds
	Serviceberry buds
	Rose hips
	Sunflower seeds
March	Wheat seeds
	Grass seeds
	Sunflower seeds
	Sagebrush seed heads
April	Wheat
	Alfalfa
	Grass seeds and leaves
	Insects
May	Alfalfa
	Grass leaves
	Wheat seeds
	Wyethia
June, July, and August	Grass seeds and leaves
	Insects
	Sagebrush leaves and seed heads
	Alfalfa leaves
	Chokecherry fruits
September	Grass seeds and leaves
	Chokecherry fruits
	Snowberry seeds
	Insects
October	Grass seeds and leaves
	Wheat
	Sunflower
	Rose hips
November and December	Wheat
	Grass seeds and leaves
	Sunflower
	Knotweed

of insects by juveniles declined with increasing age. Once juvenile grouse switched to plant material, they consumed the same foods as adults. Fall diets differed between years, with insects assuming a more important role as food during dry years because favored annual forbs, such as yellow salsify, knotweed, and prickly lettuce, were less abundant.

Marks and Marks (1987) examined 132 feeding sites of CSTG over three winters in western Idaho. During winter 1983-84, grouse fed extensively on hawthorn fruits in riparian areas. No evidence was found to suggest that the grouse ate hawthorn buds. When hawthorn fruits were unavailable, grouse used mountain shrub stands, where they primarily fed on

Table 11. Primary foods of Columbian sharp-tailed grouse in southeastern Idaho during summer and fall, expressed as percent of total dry weight of crop contents (from Parker 1970). Sample sizes are in parentheses.

	Summer		Fall[1]	
Food item	**Juvenile (n = 13)**	**Adult (n = 33)**	**1968 (n = 57)**	**1969 (n = 43)**
Mahonia repens	11	16	36	37
Tragopogon dubius	21	47	28	1
Taraxacum officinale	6	1	2	1
Polygonum douglasii	5	13	14	7
Eriogonum spp.			1	3
Epilobium spp.			2	1
Rosa spp.			3	1
Triticum aestivum		6		
Lactuca serriola		2	12	
Prunus virginiana		1	1	3
Amelanchier alnifolia				3
Oryzopsis hymenoides		2		
Insects	51[2]	8	1	43[3]

[1]Data for juvenile and adult grouse were combined.
[2]Primarily grasshoppers, ants, and beetles.
[3]Primarily grasshoppers.

buds of serviceberry and chokecherry. Bitter cherry (*Prunus emarginata*) was the most numerous shrub in the stands but CSTG seldom fed on it. Grouse were occasionally observed eating buds of willow, fruits and foliage of juniper, thistle seeds, and green grass near seeps.

Schneider (1994) investigated the winter food habits of CSTG in southeastern Idaho. Diet composition was reported as percent use on a dry weight basis (dry weight of each food item divided by total dry weight of all food items present in the crops times 100) and as frequency of occurrence (**Table 12**). Columbian sharp-tailed grouse consumed twenty-five different forage species (seven shrubs, 15 forbs, three insects) during winter, but percent use exceeded 2 percent for only three shrubs, three forbs, and one insect. Percent use of buds and fruits from shrubs over two winters was greater than 80 percent (**Table 12**). Grouse (n = 46) collected from riparian and mountain shrub habitats selected (percent use = 84–100%) buds, fruits, and twigs from chokecherry and serviceberry (**Table 12**). Yellow salsify, alfalfa, and draba (*Draba* spp.) were the dominant foods (frequency of occurrence >98 percent) in crops of birds (n = 6) collected from CRP fields during winter (**Table 12**). Russian olive berries and midge galls (*Rhypolomyia* spp.) obtained from sagebrush plants comprised greater than 99 percent of the foods eaten by five grouse collected from Russian olive-sagebrush habitats (**Table 12**).

Schneider (1994) compared crop contents with microscopic fecal analysis to ascertain whether the latter technique was a viable, non-lethal alternative for sampling grouse diets. The comparisons produced conflicting results, leading Schneider (1994) to conclude that microscopic fecal analysis was not a reliable technique for describing CSTG winter food habits. Results of the fecal analysis indicated willow and aspen comprised over 61 percent of the diet, and chokecherry and serviceberry about 23 percent of the diet; the same combination of foods comprised less than 5 percent and greater than 82 percent of the crop contents, respectively.

Detailed food habits studies have not been conducted on CSTG in Region 2. However, many of the plants and insects identified as food in other areas also occur in Region 2 and are likely consumed by CSTG. Dargan et al. (1942) documented the food habits of CSTG in northwestern Colorado by trailing (following tracks) birds in snow and recording the plants upon which they fed. Data collected on 22 individual grouse from December through February indicated that they fed almost exclusively (>95 percent of diet) on chokecherry and serviceberry buds. Rogers (1969) reported that two

Table 12. Percent use[1] (frequency of occurrence) of food items identified from Columbian sharp-tailed grouse crops collected during winter 1992 and 1993 in southeastern Idaho (from Schneider 1994).

Food item	Pocatello Valley Winter 1992 (*n* = 18)	Pocatello Valley Winter 1993 (*n* = 34)	Curlew Valley Winter 1993 (*n* = 5)
Amelanchier alnifolia buds	27.2 (5)	51.3 (31)	0
Prunus virginiana buds	45.0 (8)	33.7 (32)	0
A. alnifolia fruits	1.8 (1)	6.2 (20)	0
P. virginiana fruits	0	T[3] (2)	0
Twigs[2]	0	1.3 (20)	0
Populus tremuloides buds	0	1.9 (2)	0
Salix spp. buds	0	1.4 (3)	0
Chysothamnus viscidiflorus	2.9 (5)	0.2 (4)	0
Elaeagnus angustifolia buds	0	0	0.3 (1)
E. angustifolia fruits	0	0	84.7 (4)
Rosa woodsii hips	0	0	0.2 (1)
Triticum aestivum	1.0 (1)	0.4 (1)	0
Grass	0.9 (5)	0.6 (9)	0
Medicago sativa	2.3 (8)	2.2 (1)	0
Antennaria spp.	T (1)	0.2 (2)	0
Astragalus spp.	0	0.1 (2)	0
Ranunculus testiculatus	0.2 (2)	0	0
Lithospermum ruderale	0	0.1 (1)	0
Draba spp.	1.4 (9)	T (4)	0
Tragopogon dubius	0.5 (2)	0	0
Thelypdium spp.	0.8 (2)	0	0
Arabis spp.	T (1)	0	0
Lactuca serriola	0.1 (2)	T (1)	0
Caryophyllaceae (pink)	2.1 (5)	T (3)	0
Liliaceae (lilly)	0	T (1)	0
Polemoniaceae (phlox)	0.1 (1)	0.1 (3)	0
Unknown forbs	T (1)	0.2 (8)	0
Acrididea (grasshopper)	0.2 (1)	T (1)	0
Rhypolomyia (midge) galls	0.1 (1)	0.1 (6)	14.4 (3)
Geometridae (moth) eggs	0	T (2)	0

[1]Calculated as dry weight of each food item divided by total dry weight of all food items present in the crops times 100.
[2]Includes twigs of *Amelanchier alnifolia* and *Prunus virginiana*.
[3]T = trace = < 0.05 percent.

crops collected on Pinõn Mesa near Grand Junction, Colorado were filled with woolly-bear (*Isia isabella*) larvae. Common items found in crops of radio-marked grouse that were depredated and subsequently recovered during studies (Boisvert 2002, Collins 2004) in northwestern Colorado included maiden blue eyed mary (spring), alfalfa (spring, summer, and fall), common dandelion (spring, summer, and fall), yellow salsify (spring and summer), prickly lettuce (spring and summer), pale agoseris (spring and summer), quaking aspen catkins (spring), Rocky Mountain juniper berries (winter), grasshoppers (summer and fall), ants (summer), serviceberry fruits (summer and fall), and serviceberry buds (winter).

Sharp-tailed grouse, as well as other gallinaceous species, ingest small stones (grit) that accumulate in the gizzard (McCann 1939, Hoskin et al. 1970, May and

Braun 1973, Norris et al. 1975, Schneider 1994). Grit facilitates digestion by assisting in mechanical abrasion of coarse or hard foods (Nestler 1946, May and Braun 1973). Schneider (1994) analyzed gizzards from 49 CSTG collected over two winters. Grit was present in 86 percent of the gizzards examined. Of the seven gizzards that contained no stones, four contained only chokecherry seeds, one contained only serviceberry seeds, and two contained no stones or seeds. During the mild winter of 1992 when grit was readily available, stone mass and number of stones per gizzard averaged 0.64 g and 21.8, respectively. In 1993, persistent snow cover reduced the availability of grit, and stone mass and number of stones per gizzard averaged only 0.30 g and 9.1, respectively. Mean stone size did not differ between winters (1992 = 2.13 mm, 1993 = 2.26 mm). Comparisons between males and females indicated no differences in mean number, mass, or size of stones. Schneider (1994) found that during winters of reduced stone availability, CSTG retained chokecherry seeds in their gizzards. These seeds were worn, suggesting that they functioned in the same manner as stones in grinding of winter foods.

Food selection

Selection of plants and plant parts by grouse during winter when their diets are highly restricted has generally been associated with higher protein levels (Hoffmann 1961, Pulliainen 1970, Gurchinoff and Robinson 1972, Hohf et al. 1987) or lower levels of secondary plant constituents (Bryant and Kuropat 1980, Remington and Braun 1985, Jakubas et al. 1989). Schneider (1994) found no evidence that CSTG selected winter foods based on crude protein content or total phenolics. He cautioned that measuring total phenolics might not reflect food selection patterns. Plants often contain a large number of secondary plant compounds (Robbins 1993), any of which could act as a possible deterrent to feeding. Jakubas et al. (1989) reported no differences in total phenolics between preferred and non-preferred forages (i.e., aspen buds) of ruffed grouse. Upon further investigation, Jakubas et al. (1989) found that ruffed grouse feeding preferences were related to levels of coniferyl benzoate, a specific phenolic found in aspen bud scales. Schneider (1994) recommended that the role of secondary plant compounds on foraging behavior of CSTG needs further study before specific conclusions can be reached. Winter forage selection by CSTG may represent a strategy of maximizing intake of metabolizable energy while meeting nitrogen requirements similar to what Remington and Hoffman (1996) reported for dusky grouse. Dusky grouse preferred foods from which they extracted the most energy, but these foods were not necessarily superior by conventional nutritional analyses (Remington and Hoffman 1996).

Studies indicate that CSTG remain in shrubsteppe or CRP cover types when snow conditions permit (Sirotnak et al. 1991, Schneider 1994, Ulliman 1995b, McDonald 1998). Within these cover types, they primarily feed upon forbs, berries, and insects, whereas grouse using mountain shrub mainly consume buds from deciduous shrubs. Schneider (1994) reported that grouse using CRP fields in southeastern Idaho consumed foods with more protein and minerals, and less fiber and total phenolics than grouse in mountain shrub habitats. This may explain why the grouse remained in CRP when snow conditions allowed. This is seldom an option for CSTG in Region 2 even during mild winters. Columbian sharp-tailed grouse in Region 2 are almost exclusively confined to feeding in mountain shrub habitats during winter. As previously discussed, CSTG appear to select specific areas within the mountain shrub cover type in winter. It is feasible that CSTG select these areas in part based on the nutritional characteristics of the serviceberry plants (primary winter food of CSTG in Region 2) growing there. This aspect of CSTG habitat selection in Region 2 needs further investigation.

Energetics

The specific nutritional requirements of CSTG are not known (Connelly et al. 1998). There is no empirical information on gross daily food consumption by CSTG in the wild or in captivity. McEwen et al. (1969) estimated the average daily intake of plains sharp-tailed grouse raised in captivity as 30 g air-dry weight per mature grouse. This estimate has little value in extrapolating to wild birds because captive birds were fed a combination of commercial game bird chow, mixed grains, and alfalfa hay.

Evans and Dietz (1974) conducted feeding trials of plains sharp-tailed grouse captured in the wild and maintained in captivity during winter. The trials involved feeding three to four grouse a single-component diet for four days and measuring total intake and collecting all excreta. Male grouse were fed one of the following seven food items: corn kernels, buds from plains cottonwood (*Populus deltoides*), and fruits from silver buffaloberry (*Shepherdia argentea*), hawthorn, Russian olive, western snowberry (*Symphoricarpos occidentalis*), and Woods' rose (*Rosa woodsii*). Mean daily intake (dry matter) ranged from 21.5 g per grouse per day for air-dried cottonwood buds to 100.3 g per grouse per day for frozen western snowberry fruits.

Female grouse were fed silver buffaloberry, Russian olive, and hawthorn; the corresponding intake was 38.5, 47.5, and 55.7 g per grouse per day. Females consumed an average of 31.5 percent less dry matter when fed the same food as males. Grouse lost nitrogen on a diet of cottonwood buds and Woods' rose, maintained a zero nitrogen balance on corn, Russian olive, and hawthorn, and gained nitrogen on western snowberry and silver buffaloberry fruits. Average nitrogen-corrected metabolizable energy values (kcal per g of dry matter intake) ranged from 3.9 for corn to 1.4 for rose. Despite the lower intake by females, metabolizable energy values did not differ by gender. Captive grouse varied their metabolizable energy intake from 58 to 444 kcal per day depending on the food they were being fed. Under winter conditions, Evans (1971) estimated that sharp-tailed grouse require an intake of at least 100 kcal per day to maintain a constant body weight.

Columbian sharp-tailed grouse in Region 2 are believed to persist on a nearly monophagous diet of serviceberry and/or chokecherry buds during most winters. Giesen (1992) and Collins (2004) reported that mean body mass of adult male CSTG harvested or captured during fall was less than mean body mass of adult males captured on leks during spring. This implies that adult males gain weight over winter while presumably persisting on a diet of serviceberry buds. Greater sage-grouse (Beck and Braun 1978), white-tailed ptarmigan (May 1975), and sooty grouse (*Dendragapus fuliginosus*; Zwickel and Bendell 2004) are other examples of grouse that gain weight over winter while subsisting on a diet of one or two plant species.

Compared to items eaten at other times of the year, winter foods consumed by grouse are often less nutritious but more abundant and readily available. The basic feeding strategy of grouse with restricted winter diets, such as CSTG, is to pass large quantities of food through their digestive system. This strategy is possible because grouse have large, well-developed crops that allow them to store food for later processing. Captive sharp-tailed grouse fed a low protein diet of hawthorn fruits compensated for the lack of protein and maintained nitrogen balance by consuming large quantities of berries (Evans and Dietz 1974).

Schneider (1994) measured the nutrient levels (dry mass basis) for dominant foods selected by CSTG during winter in southeastern Idaho. This analysis included chokecherry and serviceberry buds, two of the most common foods consumed by CSTG in Region 2 during winter. Nutrient levels for chokecherry averaged 14.7 percent crude protein, 51.2 percent fiber, 4.5 percent lipids, 4.5 percent minerals, 2.3 percent total phenolics, and 4.8 kcal per g gross energy. For serviceberry, the mean nutrient levels were 8.4 percent crude protein, 50.2 percent fiber, 5.7 percent lipids, 5.1 percent minerals, 2.7 percent total phenolics, and 4.7 kcal per g gross energy. In comparison, gross energy and crude protein of silver buffaloberry, one of the common foods of plains sharp-tailed grouse, average 4.9 kcal per g and 8.4 percent, respectively (Evans and Dietz 1974). Captive grouse maintained a positive nitrogen balance and gained weight on a diet of silver buffaloberry (Evans and Dietz 1974).

Demography

Genetic considerations

Sharp-tailed grouse, greater prairie-chickens, and lesser prairie-chickens (genus *Tympanuchus*) are genetically distinct from other grouse species (Ellsworth et al. 1995, 1996). However, within the genus *Tympanuchus*, no clear genetic distinctions occur among species for either mtDNA or allozymes despite marked behavioral and morphological differences (Ellsworth et al. 1994). Two hypotheses may account for the similarity among the three taxa. The first is that differentiation occurred in geographic isolation during Pleistocene glacial advances, but genetic evidence of such an event has been lost upon secondary contact due to hybridization. Ellsworth et al. (1994) acknowledged that sporadic hybridization occurs among prairie grouse, but they contended it is more common currently (post-settlement) than historically (pre-settlement) and, therefore, is not a significant factor affecting genetic similarity within *Tympanuchus*. The second hypothesis proposed by Ellsworth et al. (1994) is that subdivision among prairie grouse occurred during the Wisconsin glacial period (Hubbard 1973), which was sufficiently recent so that all populations of *Tympanuchus* still retain (share) ancestral genetic polymorphisms that arose prior to divergence. In other words, mtDNA lineages may not have had sufficient time to sort phylogenetically such that each taxon constitutes a distinct lineage. Ellsworth et al. (1994) proposed that morphological and behavioral differentiation among sharp-tailed grouse, greater prairie-chickens, and lesser prairie-chickens has been driven by sexual selection and appears to have evolved rapidly relative to mtDNA and allozymes.

Spaulding et al. (2006) provided evidence that populations of CSTG in British Columbia, Washington, Idaho, and Utah are genetically distinct from other subspecies of sharp-tailed grouse and should be

managed as a distinct entity. Analyses of nuclear data obtained from CSTG in northwestern Colorado (Region 2) indicated a closer alliance with plains sharp-tailed grouse than CSTG collected in British Columbia, Washington, Idaho, and Utah (Spaulding et al. 2006). While Spaulding et al. (2006) did not go so far as to say that the sharp-tailed grouse in northwestern Colorado are not of the Columbian subspecies, they did report that those grouse are genetically different from other populations of CSTG sampled. They recommended that CSTG in northwestern Colorado not be used as a source of transplant stock outside of Colorado until the uncertain status of this population is further investigated. Spaulding et al. (2006) did not include any samples of CSTG from Wyoming in their analyses. Presumably, the Colorado and Wyoming populations have similar genetic characteristics, since they are contiguous. This should be confirmed by collecting and analyzing samples from Wyoming along with additional samples from Colorado. In conjunction with genetic surveys, studies of morphology, behavior, and habitat use should be undertaken to further characterize sharp-tailed grouse in this portion of the range.

Fundamental to population genetics is the knowledge that small or isolated populations lose genetic variation over time, thereby increasing the probability of extinction and decreasing the probability of future adaptive change (Lande and Barrowclough 1987). The genetic structure of a population is affected, in part, by gene flow. As gene flow decreases, genetic variation is lost due to random genetic drift (Ewens et al. 1987, Slatkin 1987). Genetic variation is believed to be important for a population's long-term persistence because it reduces the deleterious effects of inbreeding and random loss of alleles through genetic drift. For CSTG, broad-scale loss and fragmentation of suitable habitats throughout its range have isolated remaining populations to the extent that there currently is little or no possibility of natural gene flow among populations. If loss and degradation of suitable habitats continues, genetic consequences may be serious. Recent genetic studies suggest that some consequences are already happening. For example, Warheit and Schroeder (2001) analyzed blood samples from CSTG collected in north-central Washington and southeastern Idaho and found that the populations were significantly different genotypically. This suggests little or no gene flow between the two areas and that the populations are on different evolutionary trajectories. Perhaps more alarming, they presented preliminary evidence that the Washington population was experiencing reduced genetic variability due to inbreeding.

Studies of greater prairie-chickens in Illinois illustrate the potential consequences when populations decline and become increasingly isolated. The Illinois population of greater prairie-chickens declined from an estimated several million birds distributed over 60 percent of the state during the mid-1800's to 2,000 individuals in 179 subpopulations in 1962 to 46 individuals in two populations by 1994 (Westemeier et al. 1998). The decline occurred despite efforts to improve habitats, control nest parasitism by ring-necked pheasants (*Phasianus colchicus*), and control nest predators. Decreased reproductive performance in the form of lower egg fertility and hatching rate was associated with the contraction and decline of the population (Westemeier et al. 1998). Genetic studies indicated significantly lower levels of genetic diversity in the Illinois population than in larger, more contiguous populations (Bouzat et al. 1998). In an effort to enhance genetic diversity, greater prairie-chickens were translocated to Illinois from Minnesota, Kansas, and Nebraska. Westemeier et al. (1998) predicted the Illinois population would have become extinct had it not been for this intervention.

Reproductive performance

Subadult male sharp-tailed grouse are apt to occupy peripheral territories on the lek and are seldom successful in attracting females for mating (Rippin and Boag 1974a, Moyles and Boag 1981). This does not mean they are not capable of breeding. Nitchuk and Evans (1978) measured the volume of spermatozoa in testes of central and peripheral males collected from large and small dancing grounds in central Manitoba, Canada. They did not report the age of the grouse collected, but it is likely that some of the peripheral males were subadults. All birds (n = 74) collected appeared to be physiologically capable of breeding. Hjorth (1970) observed numerous copulations by first-year males when one of the adult central males failed to return to the lek after being trapped. Although first-year males produce viable sperm, evidence indicates their testis volume is smaller than that of adult males (Tsuji et al. 1992). Consequently, they may deliver a lower amount of sperm per ejaculation and are less able to perform multiple copulations than adult males are (Tsuji et al. 1992).

Adult males occupying central territories on the lek perform most copulations. All females apparently breed in their first year after hatch and attempt to lay at least one clutch per nesting season (Connelly et al. 1998). Nesting rates (percent of females that survive

to the nesting season that attempt to nest) reported for CSTG range from 91 to 100 percent (**Table 13**). Meints (1991), McDonald (1998), and Boisvert (2002) concluded that the nesting rate for radio-marked hens in their studies was probably 100 percent, but because some nests were lost during the laying period, some nesting effort went undetected. Most nests of radio-marked hens are found during incubation when the hen spends over 95 percent of her time on the nest. Nests are seldom located during laying because hens spend little time at the nest except to lay an egg. Thus, a hen that loses her clutch during laying is likely to be classified as not attempting to nest. McDonald (1998) reported that these hens often exhibit localized movements typical of hens during the laying period, suggesting they attempted to nest. Attempts to measure nesting rates of CSTG have been based on radio-marked hens initially captured on leks. It is unknown whether there is a non-breeding segment of the female population that does not visit leks to mate and subsequently lay a clutch of eggs.

Both adult and subadult females may lay a replacement clutch (renest) if their first clutch is lost or abandoned (Connelly et al. 1998). Renesting rates (proportion of females that survive their initial nest failure that attempt to renest) vary annually and regionally from less than 20 to over 75 percent (Meints 1991, Apa 1998, McDonald 1998, Boisvert 2002, Collins 2004). Renesting rates in Region 2 (24 to 47 percent) appear to be lower than those reported elsewhere (**Table 13**), with the exception of the 15 percent renesting rate reported by Apa (1998) for southeastern Idaho. Apa (1998) noted he probably failed to detect all renesting attempts because he did not intensively monitor females after they lost their first clutch.

The probability a female will renest is greater if she loses her clutch during laying or early in the incubation period. The probability of laying a replacement clutch also is greater for adult than subadult females (Bergerud 1988a). In northwestern Colorado, 53 percent of 32 adult female CSTG renested compared to only 17 percent of

Table 13. Reproductive parameters of Columbian sharp-tailed grouse in northwestern Colorado (Giesen 1987, Boisvert 2002, Collins 2004), eastern Idaho (Meints 1991), and eastern Washington (McDonald 1998). Sample sizes are in parentheses.

Reproductive parameter	Boisvert (2002)	Collins (2004)	Giesen (1987)	Meints (1991)	McDonald (1998)
Nesting effort, %[1]	98 (62)	98 (121)	—	100 (20)	91 (44)
Renesting effort, %[2]	24 (33)	47 (38)	—	80 (5)	73 (22)
Hen success, %[3]	47 (62)	71 (121)	—	86 (20)	49 (45)
Nest success, %[4]	42 (67)	63 (137)	62 (13)	72 (25)	41 (54)
Nest success, %, initial nest	44 (59)	62 (119)	—	—	41 (37)
Nest success, %, renest	38 (8)	67 (18)	—	—	41 (17)
Clutch size, initial nest	10.2 (39)	10.4 (71)	10.8 (10)	11.9 (19)	12.2 (17)
Clutch size, renest	7.8 (5)	8.5 (11)	—	10.0 (4)	9.5 (10)
Initial clutch size, adult	10.2 (33)	10.4 (60)	—	—	—
Initial clutch size, subadult	10.2 (6)	10.5 (11)	—	—	—
Hatching success, %[5]	91 (367)	94 (835)	—	91 (196)	95 (183)
Egg fertility, %	93 (367)	97 (739)	—	—	—
Brood success, %[6]	76 (28)	58 (79)	—	—	50 (22)
Brood size[7]	4.4 (21)	3.4 (46)	—	4.1 (16)	2.5 (11)

[1]Proportion of females alive at the onset of the nesting season that attempted to nest.
[2]Proportion of females that survived their initial nest failure that attempted to renest.
[3]Proportion of females that hatched at least one egg.
[4]Proportion of nests in which at least one egg hatched. Includes initial nests and renests.
[5]Proportion of eggs in successful nests that hatched.
[6]Proportion of females that successfully nested and still possessed at least one chick at 45 (McDonald 1998) and 49 days (Boisvert 2002, Collins 2004) post-hatch.
[7]Mean brood size at 28 (Meints 1991), 45 (McDonald 1998), and 49 days (Boisvert 2002, Collins 2004) post-hatch. Based on radio-marked females that still possessed chicks at the time counts were conducted.

six subadult females (Collins 2004). Some females will attempt to renest more than once within a single nesting season (Apa 1998, McDonald 1998, Boisvert 2002). Multiple renesting attempts are probably rare within Region 2 because the nesting season is later. Thus, the opportunity for renesting is shorter.

Greater prairie-chickens (means = 8.2 to 12.9 eggs; Schroeder and Robb 1993), lesser prairie-chickens (mean = 10.4 eggs; Giesen 1998), ruffed grouse (means = 9.5 to 11.5 eggs; Rusch et al. 2000), and sharp-tailed grouse (means = 10.9 to 12.3 eggs; Connelly et al. 1998) lay the largest clutches of any North American grouse. Columbian sharp-tailed grouse have the smallest clutch size among the six subspecies of sharp-tailed grouse (Connelly et al. 1998). Populations of CSTG in the southern portion of the range (i.e., Region 2) have smaller clutches than more northern populations. In northwestern Colorado, average clutch sizes for initial nests were 10.2 (Boisvert 2002), 10.4 (Collins 2004), and 10.8 eggs (Giesen 1987) (**Table 13**). In comparison, clutch sizes for initial nests averaged 10.9 eggs in northern Utah (Hart et al. 1950), 11.9 eggs in eastern Idaho (Meints 1991), and 12.2 eggs in eastern Washington (McDonald 1998). This pattern is in accordance with the "egg rule" (Terres 1956), which states that clutch size of many birds increases with increasing latitude.

Within Region 2 (Boisvert 2002, Collins 2004), and elsewhere throughout the range of the CSTG (Meints 1991, McDonald 1998), clutch sizes of initial nests are larger than those of renests by approximately two eggs (**Table 13**). Boisvert (2002) is the only investigator that reported mean clutch size of renests for adult and subadult females. Sample sizes are small, but the data indicate no difference in clutch size of renests between adult (n =3, mean = 8.0 eggs) and subadult females (n = 2, mean = 7.7).

Numerous investigators have reported estimates of nesting success (proportion of all clutches initiated that hatch at least one egg) for CSTG (Hart et al. 1950, Giesen 1987, Marks and Marks 1987, Meints 1991, Schroeder 1994, Apa 1998, McDonald 1998, Boisvert 2002, Collins 2004). These studies show that nesting success varies among years and among areas within the same year due to differences in weather conditions, age structure of nesting females, and predation rates. Estimates of nesting success range from 37 percent for 110 nests in Utah (Hart et al. 1950) to 72 percent for 25 nests in eastern Idaho (Meints 1991). The combined nest success for 191 nests located by Giesen (1987), Boisvert (2002), and Collins (2004) in Region 2 was 57 percent (range = 42 to 63%; **Table 13**). Apa (1998) reported 51 percent success for 47 nests in southeastern Idaho. Nest success for nine nests in western Idaho was 56 percent (Marks and Marks 1987). Nest success in eastern Washington was estimated by Schroeder (1994) as 60 percent for 10 nests and by McDonald (1998) as 41 percent for 54 nests. McDonald (1998), Boisvert (2002), and Collins (2004) found no difference in nesting success between initial nests and renests (**Table 13**). Collins (2004) also found no difference in nest success between adult (59 percent) and subadult females (56 percent).

Hen success is defined as the proportion of females that hatch at least one egg regardless of the number of nesting attempts. If no hens in a population renest or if all renesting attempts fail, hen success will equal nest success. Since this is rare, estimates of hen success usually exceed estimates of nest success (**Table 13**). In Region 2, of 183 females monitored by Boisvert (2002) and Collins (2004), 115 (63 percent) hatched at least one egg. Generally, if a female successfully incubates a clutch of eggs, the hatching success (proportion of eggs in successful nests that hatch) is high (>90 percent; **Table 13**). Egg fertility also is high (>90 percent; **Table 13**) and typically exceeds hatching success by 2 to 3 percent because infertile eggs are not the only eggs that may fail to hatch in successful nests. In some cases, unhatched eggs are fertile, but the embryos only partially develop. In other cases, the eggs contain fully-developed embryos that failed to hatch or that only partially hatched. This may result from hens leaving the nest before all eggs hatch.

Fledging success is the percent of all eggs laid that produce young surviving to the stage where they become independent of the brood hen (10 to 12 weeks). No studies have measured fledging success for any of the subspecies of sharp-tailed grouse. However, Boisvert (2002) and Collins (2004) calculated brood success (proportion of females that successfully nested that still possessed at least one chick at 7 weeks post-hatch) for CSTG in northwestern Colorado (**Table 13**). The combined estimate of brood success was 63 percent. Approximately 37 percent of all females alive at the onset of the nesting season had at least one chick surviving until mid-August. The total number of chicks counted at seven weeks post-hatch was 248 for an average brood size of 3.7 chicks per successful female or 1.4 chicks per female alive at the onset of the nesting season.

Of 2,066 CSTG wings collected by Giesen (1999) in northwestern Colorado during fall hunting seasons

from 1976 to 1997, 902 (43.7 percent) were classified as adults (includes subadults) and 1,164 (56.3 percent) as juveniles. This equates to 1.3 juveniles per adult in the fall harvest. Based on gonadal inspection of 93 adults in the fall harvest, Giesen (1999) estimated that 54.8 percent were females. Thus, of the 902 wings classified as adults, approximately 494 should have been females. Therefore, the juvenile per female ratio was 2.4. This exceeds the estimate of 1.4 juveniles per female in mid-August using data collected by Boisvert (2002) and Collins (2004) in northwestern Colorado. It is possible that harvest samples do not accurately reflect the composition of the population or that Boisvert (2002) and Collins (2004) under-estimated brood sizes.

Survivorship

Ammann (1957) estimated the average lifespan for prairie sharp-tailed grouse in Michigan as 1.6 years for males and 1.5 years for females. Individuals over five years of age were rare. The oldest known grouse was a male that was at least 7.5 years old when it was shot. Hamerstrom and Hamerstrom (1951) reported the oldest known age for a sharp-tailed grouse in Wisconsin was 4.5 years. Five years was the longest any banded plains sharp-tailed grouse in South Dakota was recaptured or recovered following its capture (Robel et al. 1972). Survival data for greater prairie-chickens and plains sharp-tailed grouse in Nebraska indicated few grouse lived past two to three years of age (Sisson 1976). Of 41 banded grouse for which age at death was known, 90 percent were less than three years of age and the oldest was between five and six years of age (Sisson 1976).

Longevity data for CSTG are lacking because there have been no long-term (over four years) studies of this subspecies. Collins (2004) monitored two radio-marked females through three consecutive nesting seasons. Both females were captured on leks in spring as adults (at least two years of age). Thus, they were at least five years old entering their third nesting season.

Annual survival estimates for radio-marked CSTG vary from a low of 20 percent to a high of 55 percent (**Table 14**). This is comparable to annual survival rates reported for prairie sharp-tailed grouse in Michigan (40 percent; Ammann 1957) and plains sharp-tailed grouse in South Dakota (21 to 30 percent; Robel et al. 1972) and Nebraska (31 percent; Sisson 1976). Data collected by Ammann (1957) suggested that female prairie sharp-tailed grouse had slightly lower survival than males did. For CSTG, neither Boisvert (2002) nor Collins (2004) documented any difference in annual survival by gender, whereas McDonald (1998) reported lower annual survival among males than females.

In eastern Washington, survival of males and females did not differ between seasons on one study area, but on another area, female survival was lower during spring-summer than fall-winter (McDonald 1998). Overall, McDonald's (1998) data indicated the combined survival of males and females was lower during spring-summer (55 to 77 percent) than fall-winter (80 to 86 percent), with the lowest survival occurring during June. Survival of nesting hens (89 percent) during the incubation period was no different than for hens not engaged in nesting (96 percent). However, for the 21-day period following hatching, females with broods had lower survival (81 percent) than females without broods (97 percent). The probability that a nesting hen would survive the incubation period and, if successful, survive the initial 21-day brood-rearing period was 73 percent compared to 94 percent for females not engaged in nesting or brood-rearing.

In southeastern Idaho, Ulliman (1995b) reported that habitat use patterns and survival differed under severe and mild winter conditions. During the mild winter of 1991–92, first snowfall was in late December, maximum snow depth was 12.7 cm, and complete snowmelt in the valleys occurred by 18 February. Radio-marked grouse used CRP fields and sagebrush cover types more than expected, and survival was 86 percent (n =14) from late December to mid-March.

Table 14. Annual survival estimates of Columbian sharp-tailed grouse.

Annual survival (%)	Location	Source (basis)
20 (n = 61)	Northwestern Colorado	Boisvert 2002 (telemetry)
33 (n = 96)	Northwestern Colorado	Collins 2004 (telemetry)
45 (n = 100)	Northwestern Colorado	Collins 2004 (telemetry)
42 (n = 927)	Northwestern Colorado	Giesen 1987 (harvest samples)
53 (n = 41)	Eastern Washington	Schroeder 1994 (telemetry)
55 (n = 38)	Eastern Washington	McDonald 1998 (telemetry)

During the more severe winter of 1992-93, snowfall began in November, maximum snow depth was 45.7 cm, and complete snowmelt did not occur until 26 March. Radio-marked grouse used riparian shrub cover types more than expected and survival was only 29 percent (n = 14) from late December to mid-March.

Boisvert (2002) reported that seasonal survival of CSTG in northwestern Colorado was greatest during summer/brood-rearing, fall, and winter, and lowest during breeding and nesting (**Table 15**). Survival was lower during the nesting season than in summer, fall, and winter in both years of study, and lower during the breeding season compared to summer, fall, and winter in 2000. Boisvert (2002) conducted a proportional hazards analysis on seven covariates, including age, gender, and habitat use, potentially influencing survival time of CSTG during the spring through fall period when they are in breeding areas. The most significant variable predicting time of survival was proportional use of CRP followed by proportional use of shrubsteppe. Columbian sharp-tailed grouse using grass and mine reclamation cover types had the lowest hazard ratios. Compared to CSTG using mine reclamation, grouse using CRP and shrubsteppe were 11.1 and 8.7 times more likely to die.

Collins (2004) reported that during the period when grouse are in breeding areas (April to October), survival of females using the shrubsteppe cover type (55 percent) did not differ from survival of females using mine reclamation (51 percent). Within cover types, survival did not differ among seasons for female grouse using mine reclamation (**Table 15**). For females using shrubsteppe, survival in 2001-2002 was greater during the breeding season than during the summer and winter seasons. Survival in 2002-2003 was higher during the nesting season compared to the summer and fall seasons. Comparisons between cover types indicated that females using mine reclamation had higher survival during summer (brood-rearing) and winter than females using shrubsteppe, which had higher survival than females using mine reclamation during the breeding season. Comparisons by gender showed males had higher survival than females during the nesting, brood-rearing, and fall seasons. Survival of males was lower than females during the breeding season, but the difference was not significant.

McDonald (1998) estimated survival until 45 days post-hatch was only 12 percent for 243 chicks on two different study areas in eastern Washington. Boisvert (2002) monitored 28 broods in northwestern Colorado from time of hatch until seven weeks post hatch during 1999 (n = 14) and 2000 (n = 14). Estimated chick survival was 49 (1999) and 47 percent (2000). Over two years of moderate (2001) to severe (2002) drought conditions in northwestern Colorado, estimated survival of 785 chicks until seven weeks post-hatch was 20 percent (Collins 2004). Survival of 677 chicks in broods of adult females was 23 percent compared to 9 percent survival for 108 chicks in broods of subadult females (Collins 2004). Within the shrubsteppe cover type, chick survival did not differ between years (2001= 13%, 2002 = 14%). In mine reclamation, chick survival during the moderate drought year (2001 = 45%) was significantly greater than survival (2002 = 20%)

Table 15. Seasonal survival estimates of Columbian sharp-tailed grouse in northwestern Colorado (Boisvert 2002, Collins 2004).

Source	Breeding	Nesting	Summer[1]	Fall	Winter
Boisvert (2002)[2]					
1999	77	77	93	90	82
2000	78	78	87	93	87[3]
Collins (2004)[4]					
2001 MR females	73	75	94	84	70
2001 SS females	100	86	80	83	44
2002 MR females	86	92	76	84	76
2002 SS females	96	100	78	77	83
2002 MR males	68	100	100	100	66

[1]Includes brood-rearing season.

[2]Data includes males and females combined.

[3]Study terminated before the winter period ended.

[4]Survival estimated by cover type (MR = mine reclamation, SS = shrubsteppe) and by gender for females in both years and males in 2002 only for the MR cover type. Sample sizes for males in the SS cover type were inadequate to estimate survival.

during the severe drought year. Chick survival in mine reclamation was greater than in shrubsteppe during the moderate drought in 2001 but not during the severe drought in 2002.

Population model

Matrix demographic models facilitate assessment of critical transitions in the life history of an animal. The first step is to create a life cycle graph from which to compute a projection matrix amenable to quantitative analysis using computer software (Caswell 2001). A stage-classified life cycle graph was constructed for CSTG that had two stages (**Figure 7**), first-year and adult females (second year and older). From the life cycle graph, a matrix population analysis was conducted assuming a birth-pulse population with a 1-year census interval and a post-breeding census (McDonald and

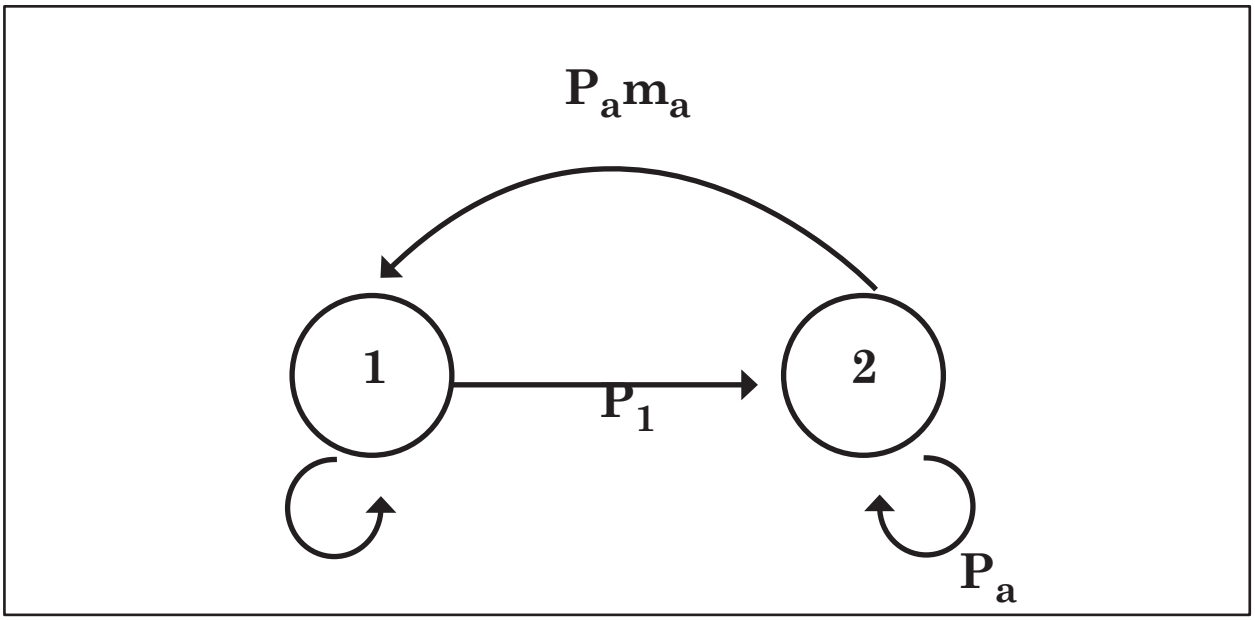

Figure 7. Life cycle graph for Columbian sharp-tailed grouse. The numbered circles (nodes) represent the two stages (first year females = node 1, adult females = node 2). The arrows (arcs) connecting the nodes represent the vital rates (transitions between stages, survival or fertility). The horizontal arc describes survival rates (P_1). The arc that points from node 2 to node 1 describes fertility (e.g., $P_a * m_a$). The self-loop on node 1 denotes fertility of first-year birds at the end of their first year (i.e., as yearlings), following their survival (P_1) through a one-year interval from censusing as chicks to just before they are censused again at the start of their second year of life. The self-loop on node 2 represents the (constant) annual probability of survival for adult females. Each of the arcs corresponds to a cell in the matrix of **Figure 8**.

(A) Stage	1	2
1	$P_1 * m_1$	$P_a * m_a$
2	P_1	P_a

(B) Stage	1	2
1	0.243	0.426
2	0.352	0.441

(C) Stage	1	2
1	0.341	0.596
2	0.493	0.617

(D) Stage	1	2
1	0.513	0.898
2	0.352	0.441

(E) Stage	1	2
1	0.436	0.763
2	0.414	0.518

Figure 8. Matrix of vital rates corresponding to the Columbian sharp-tailed grouse life cycle graph (**Figure 7**). (A) Symbolic values for the cells of the projection matrix; (B) numeric values for the "face-value" model; (C) numeric values for the stationary model with survival adjusted upwards; (D) numeric values for the stationary model with chick production adjusted upwards; and (E) numeric values for the stationary model with survival and chick production adjusted upwards.

Caswell 1993, Caswell 2001). The breeding pulse comes at the end of each 1-year census interval. All calculations used *Mathematica*™ programs written by D. B. McDonald at the University of Wyoming, mostly following algorithms in Caswell (2001).

Four different models were constructed. One model used the available demographic data (vital rates) at "face value" and three "stationary" models used adjustments of the vital rates to arrive at a population growth rate (λ) close to 1.0. The demographic term for a population that is neither growing nor decreasing in size is a "stationary" population. For the face value model, the following criteria were used to estimate vital rates.

- Number of fledgling females per female (0.84) was calculated based on data collected by Boisvert (2002) and Collins (2004).

- Survival was based on a "best estimate" value of 0.40 over all age classes. Because few data were available, a preliminary estimate of first-year survival was set at 80 percent of the adult level. Survival estimates were estimated based on a proportion of 0.56 adults and 0.44 first-year birds from an initial assessment of the stable stage distribution. These assumptions led to a first-year survival rate of 0.352 and an adult survival rate of 0.441.

- The available data yielded an overall estimate of 0.84 female chicks raised to the 7-week stage per female. Based on data for differential success of first-year birds, their success was set at 71.4 percent of that of adult birds. Using the age ratio of 0.56 adults and 0.44 first-year birds produced an estimate of 0.967 female chicks for adult females and 0.691 female chicks for first-year females.

For the "stationary models", the following criteria were used to estimate vital rates.

- Survival adjusted upward. Overall survival was adjusted upward to 0.56, yielding a population growth rate (λ) of 1.04. A deterministic growth rate slightly higher than 1.0 was used because it provides a buffer against the detrimental and inevitable effects of variation in the vital rates due to environmental stochasticity.

- Chick production adjusted upward. Chick production was set at 1.77, yielding a λ of 1.04.

- Survival and chick production adjusted upward. Survival was adjusted upward to 0.47 and chick production to 1.28, yielding a λ of 1.04.

All models assumed female demographic dominance so that fertilities are given as female fledglings per female. Thus, the fledgling number used was half the total annual production of fledglings assuming a 1:1 sex ratio. The models had two input terms: P_i describing survival rates, and m_i describing fertility (**Table 16**). The symbolic terms in the projection matrix corresponding to the life cycle graph and the numeric values for the face-value and three stationary models are shown in **Figure 8**. The fertility terms in the top row of the matrix includes a term for offspring production (m_i), as well as a term for the survival of the mother (P_i) from the census (just after the breeding season) to the next birth pulse almost a year later.

The face value model yielded a population growth rate (λ) of 0.742, indicating an annual and unsustainable decline of 35.8 percent. This estimate is probably the result of imprecise data and should not be interpreted

Table 16. Vital rates for the face value and stationary matrix projection models. Only the rates that differ from the face value model are shown for the stationary models with adjusted vital rates.

			Stationary (λ = 1.04)[1]		
Vital rate	**Description**	**Face value**	**Model 1**	**Model 2**	**Model 3**
m_1	Chicks per first-year female	0.69		1.46	1.05
m_a	Chicks per adult female	0.97		2.04	1.47
P_1	Female chicks per first-year female	0.35	0.49		0.41
P_a	Female chicks per adult female	0.44	0.62		0.52

[1]Model 1 survival adjusted upwards; model 2 chick production adjusted upward; model 3 both survival and production adjusted upwards.

as an indication of the general well-being or stability of the population. Likewise, λ for the stationary models does not accurately reflect what is happening in the real population. It was set at 1.04 only as a target towards which to adjust the vital rates. The modeling exercise indicated that more detailed and long-term population data are needed to have any confidence in the estimation of λ. Despite limitations, the models provide a basis using sensitivity and elasticity analyses for assessing the relative vulnerability of portions of the life cycle when considering management of CSTG.

Sensitivity is the effect on λ of an absolute change in the vital rates (i.e., survival and fertility). Sensitivity analysis provides useful information about the state of the population (Caswell 2001).

- Sensitivities show how important a given vital rate is to λ and can be a useful integrative measure of overall fitness.
- Sensitivities can be used to evaluate the effects of inaccurate estimation of vital rates from field studies.
- Sensitivities can quantify the effects of environmental perturbations wherever those can be linked to effects on age-specific survival or fertility rates.
- Sensitivities allow researchers to identify and focus their efforts on the vital rates in most need of study.

For the face value and survival-adjusted models (**Figure 9**), λ was most sensitive to changes in adult survival (32 percent of total sensitivity) closely followed by first-year survival (27 percent of total sensitivity). Under the fertility-adjusted model and the model where fertility and survival were adjusted (**Figure 9**), λ was most sensitive to changes in first-year survival (38 percent of total sensitivity). The sensitivity analysis suggests that survival rates are most important to population viability.

Elasticities are useful in resolving a problem of scale that can affect conclusions drawn from sensitivity analysis. Interpreting sensitivities can be misleading because survival and reproductive rates are measured on different scales. Elasticities are the sensitivities of λ to proportional changes in vital rates. Elasticities partly avoid the problem of differences in units of measurement associated with sensitivity estimates and have the useful property of summing to 1.0. The difference between conclusions of elasticity and sensitivity analyses result from weighting of elasticities by the value of the original vital rates. Management conclusions will depend on whether the changes in vital rates are likely to be absolute (guided by sensitivities) or proportional (guided by elasticities). By using elasticities, one can further assess key life history transitions and stages as well as the relative importance of reproduction and survival for a population. It is important to note that elasticity and sensitivity analysis assume the magnitude of the changes (perturbations) to the vital rates is small. Large changes require a reformulated matrix and reanalysis.

Under the face value and survival-adjusted models (**Figure 10**), the λ of CSTG was most elastic to changes in adult survival (37 percent of total elasticity). For the fertility-adjusted model and the model in which fertility and survival were adjusted (**Figure 10**), λ was equally and most elastic to first-year survival and adult fertility

(A) Stage	1	2
1	0.377	0.441
2	0.533	0.623

(B) Stage	1	2
1	0.532	0.313
2	0.796	0.468

Figure 9. Sensitivity matrix for (A) the face value model with λ = 0.742 and (B) for the fertility-adjusted stationary model with λ = 1.04. Sensitivities for the survival adjusted model and the fertility and survival-adjusted model are not shown because the values are nearly the same as for the face value and fertility-adjusted models, respectively.

(A) Stage	1	2
1	0.124	0.253
2	0.253	0.37

(B) Stage	1	2
1	0.262	0.27
2	0.27	0.198

Figure 10. Elasticity matrix for (A) the face value model and (B) the fertility-adjusted stationary model. Sensitivities for the survival adjusted model and the fertility and survival-adjusted model are not shown because the values are nearly the same as for the face value and fertility-adjusted models, respectively.

(each accounted for 27 percent of total elasticity). Nearly as important was first-year fertility (26 percent of total). Caswell (2001) suggests that when the elasticities and sensitivities are relatively evenly apportioned across the life history, populations should be somewhat robust to environmental variability. This seems to be the case for CSTG based on the low differences between the highest and lowest elasticity and sensitivity values (**Figure 9**, **Figure 10**).

The stable stage distribution describes the proportion of each stage or age class in a population at demographic equilibrium. Under a deterministic model, any unchanging matrix will converge on a population structure that follows the stable stage distribution regardless of whether the population is declining, stationary, or increasing. Populations not at equilibrium will usually converge to the stable stage distribution in 20 to 100 census intervals. For CSTG at the time of the post-breeding annual census (just after the end of the breeding season), the population at stable stage distribution should consist of 46 percent chicks and 54 percent adults.

Reproductive values can be considered as describing the "value" of a stage as a seed for population growth relative to that of the first (newborn or, in this case, fledgling) stage (Caswell 2001). The reproductive value is calculated as a weighted sum of the present and future reproductive output of a stage discounted by the probability of surviving (Williams 1966). The reproductive value of the first stage is, by definition, always 1.0. For CSTG, an adult female is worth 1.41 fledglings. The estimated cohort generation time for CSTG ranged from 1.9 years under the face value model to a high of 2.8 years under the survival-adjusted model. The implicit time steps in the matrix model allow one to calculate the mean and variance of ages of individuals in mixed-age stages (i.e., adults). For the face value model, the mean age of adult females was 2.5 years (SD = 1.9).

Improved estimates of survival and fertilities from Region 2 are required to refine the models and increase the relevance and accuracy of the analysis. The present analysis is only a guide to the forces acting on the demography of CSTG in Region 2. Data from natural populations on the range of variability in the vital rates would allow modeling of stochastic fluctuations. Other potential refinements include incorporating density-dependent effects. Presently, the data appear insufficient to assess reasonable functions governing density dependence.

There are seven major conclusions from the matrix projection model.

1. The primary reason for developing the matrix model was to assess critical stages in the life history of CSTG rather than to make predictions about population growth rate, population viability, or time to extinction. Insufficient data are available to make such predictions. Because data are limited, the model provides preliminary guidance on which vital rates should be the focus of future research efforts.

2. Survival accounted for approximately 60 percent of the total possible sensitivity in all models examined.

3. Survival was important to the elasticity (62 percent) of the population growth rate in two of the four models examined. In the other two models, survival (47 percent) and fertility (53 percent) were of nearly equal importance.

4. No clear pattern emerged with regards to age class (first-year and adult females) concerning the importance of fertility and survival to the population growth rate. For the face value and survival-adjusted models, adult survival appeared slightly more important to the sensitivity (32 percent) and elasticity (37 percent) of the population growth rate. In contrast, first-year survival was most important in the sensitivity analysis (36 percent) for the fertility-adjusted model and the model where fertility and survival were both adjusted.

5. Overall, the importance of the different vital rates as assessed by either the elasticity or sensitivity analysis were relatively even, suggesting that management activities that increase any of the vital rates will have a beneficial impact on population growth rate.

6. The difference between the face value vital rates and those required to maintain a stationary population indicate that fertility, survival, or both are underestimated based on the studies by Boisvert (2002) and Collins (2004) in Region 2. The estimated survival rates used in the face value model would need to increase from 0.35 to 0.49 for

first-year females and 0.44 to 0.62 for adult females to yield a stationary growth rate of 1.04, which allows for the dampening effects of variability in vital rates.

7. Another possibility is that serious declines are actually occurring in the population, but lek count data do not support this possibility. Although the counts have declined in recent years, the decline has not been as serious as the population growth rate ($\lambda = 0.742$, annual decline = 36 percent) calculated from the face value model implies.

Population regulation

Some researchers have proposed that size of breeding populations of grouse may be self-regulated through intrinsic factors, such as spacing behavior (Hannon 1988). For example, aggressive behavior by dominant females on the lek may result in delayed breeding of subordinate females, or at the extreme, prevent some females from breeding. Delays in breeding and hence nest initiation may affect an individual female's fitness because there would be less time for renesting. In addition, nests initiated later may be less successful. Robel (1970) suggested this type of behavior may occur in greater prairie-chickens. No data are available to indicate some female CSTG do not breed and subsequently attempt to nest or that nests initiated later are less successful than nests initiated early (Meints 1991, Apa 1998, McDonald 1998, Boisvert 2002, Collins 2004). If there are females that do not visit leks and presumably do not breed, they would not have been detected in these studies because only females that visited leks were captured and monitored for nesting activity. Thus, the role of female-female interactions in controlling productivity in CSTG remains unknown.

Other researchers have suggested that extrinsic factors (e.g., weather, disease, habitat, predation), either singly or in combination, influence the size of grouse breeding populations through their impact on reproduction and survival (Angelstam 1988). Connelly et al. (1998) noted that few data have been collected regarding population regulation in sharp-tailed grouse, but they cited information summarized by Bergerud (1988a) as indicating size of sharp-tailed grouse breeding populations may be correlated with annual reproductive success the preceding year (expressed as chicks per female in the fall population). The number of juveniles raised to independence per adult is a key demographic parameter in the dynamics of any grouse population. This parameter is influenced by clutch size, percentage of females nesting, renesting rates, nesting success, hatching success, and subsequent survival of juveniles to independence. Because sharp-tailed grouse have naturally high mortality rates, correspondingly high reproductive rates are essential for maintaining population stability. Numerous factors can affect reproductive success of sharp-tailed grouse, but vegetation cover (Kirsch et al. 1978) and weather (Flanders-Wanner et al. 2004) are considered most important. These two factors are not mutually exclusive. Instead, they interact as part of a complex ecological relationship between grouse and the environment to influence productivity.

In north-central Nebraska, Flanders-Wanner (2004) found that May average temperature, June average temperature, and cumulative precipitation from 1 January to 31 July (drought index) were positively correlated with plains sharp-tailed grouse production (juveniles per adult in the fall harvest); conversely, June number of heat stress days and June number of days of precipitation greater than 2.54 mm were negatively correlated with production. The most valuable predictor of productivity was the drought index, although the relationship was not straightforward. Productivity was influenced by both amount and timing of precipitation as illustrated by the fact that productivity was positively correlated with the drought index, but negatively correlated with June total precipitation. Adequate precipitation enhances vegetative growth, which in turn provides better cover for nesting and brood-rearing and more food (plants and insects) for chicks. However, if too much moisture occurs in June, especially immediately following the peak of hatch, production may be lower due to chilling of young chicks.

The controversy over what influences stability in grouse populations continues between those who argue that control occurs through intrinsic factors and those who argue control occurs through extrinsic factors. More recently, biologists are attempting to describe how intrinsic and extrinsic factors interact to regulate populations (Watson et al. 1998). Despite several long-term studies of grouse (reviewed by Boag and Schroeder 1992, Zwickel 1992, Braun et al. 1993, Schroeder and Robb 1993), the exact mechanisms of population regulation remain unclear and continue to be a subject of debate among biologists. In addition, as habitats become more fragmented and degraded, factors influencing population stability may change. Factors normally not considered as regulating healthy

populations, such as predation, disease, and hunting, may have greater influence on small, fragmented populations existing in substandard habitats.

Community ecology

Predation

Grouse die from many causes including accidents, disease, starvation, hunting, and predation. Of these causes, predation accounts for over 85 percent of all reported mortalities in grouse (Bergerud 1988a). Biologically, it has long been understood that the ultimate fate of most grouse is to be depredated and eaten by some predator. For this reason, predation is a major force in shaping the dynamics of grouse populations (Bergerud 1988a, Reynolds et al. 1988, Hewitt et al. 2001, Schroeder and Baydack 2001).

The contention of most biologists is that predation is not a factor limiting grouse populations, provided suitable habitat is available. Grouse have evolved with predators and have developed strategies to compensate for high predation rates. However, in many areas, human activities have drastically altered the landscape and possibly disrupted the balance between predators and prey in ways that favor certain predators. The extent to which human activities have influenced predation rates on CSTG has yet to be measured, but it is likely that human-related factors have contributed to an increase in some predator populations, allowed other predators to expand their range, and improved the hunting efficiency of still other predators. For example, within the range of CSTG, humans have provided mammalian predators such as common raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), and red fox (*Vulpes vulpes*) travel corridors (e.g., roads, irrigation ditches, rural developments), more diverse food supplies (e.g., grain, garbage, road kills, domestic poultry), and more places to over-winter and rear young (e.g., abandoned buildings, haystacks, barns). Humans also have provided avian predators such as common ravens (*Corvus corax*), American crows (*C. brachyrhynchos*), golden eagles (*Aquila chysaetos*), and great horned owls (*Bubo virginianus*) with more places to nest and perch in the form of trees planted by humans and artificial structures built by humans.

Ascertaining cause-specific (e.g., mammalian or avian) mortality of grouse is difficult (Lariviere 1999, Bumann and Stauffer 2002). Identifying the specific predator is even more challenging, especially for species such as sharp-tailed grouse that have a large suite of predators. The list of potential predators of CSTG in Region 2 include Cooper's hawk (*Accipiter cooperii*), great horned owl, golden eagle, northern harrier (*Circus cyaneus*), prairie falcon (*Falco mexicanus*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*B. swainsoni*), northern goshawk (*A. gentilis*), ferruginous hawk (*B. regalis*), common raven, western rattlesnake (*Crotalus viridis*), coyote (*Canis latrans*), red fox, bobcat (*Felis rufus*), weasel (*Mustela* spp.), and American badger (*Taxidea taxus*). Some of these predators take grouse year-round. Others only take grouse at certain times of the year. Still others may only prey on young grouse.

Of 15 mortalities in Utah for which a cause could be assigned, Hart et al. (1950) attributed 7 and 93 percent to avian and mammalian predators, respectively. Hart et al. (1950) specifically mention observing coyotes making successful and unsuccessful attempts to catch grouse on leks, and they provided evidence of several grouse that were attacked and killed by weasels. Hart et al. (1950) also mention California gulls (*Larus californicus*) as a potential predator of sharp-tailed grouse eggs and young. Flocks of gulls were commonly observed in alfalfa fields used by CSTG for feeding and nesting. Hart et al. (1950) speculated that gulls would prey on the eggs and young of CSTG given the opportunity. In support of this contention, Hart et al. (1950) referred to McAtee (1945) who reported California gulls preying on pheasant chicks.

In southeastern Idaho, Parker (1970) reported finding the remains of three adult CSTG in the nest of a rough-legged hawk (*Buteo lagopus*). This may be a case of misidentification. The nest was more likely that of a ferruginous hawk. Marks and Marks (1987) reported that avian predators accounted for 19 (86 percent) of 22 mortalities of CSTG in western Idaho where cause of death was ascertained. On two occasions, they flushed northern goshawks from freshly killed radio-marked male CSTG. They also found evidence of a golden eagle and great horned owl at two other mortality sites. Meints (1991) listed the fate of 48 CSTG captured and radio-marked on leks in eastern Idaho. Seven were shot, three were found dead of unknown causes, two were killed by mammalian predators, seven were killed by avian predators, and the fate of the remaining 32 grouse was unknown. Excluding hunting, seven (78 percent) of the nine known causes of death were attributed to avian predators. McDonald (1998) reported that avian predators appeared to be responsible for the majority of CSTG mortalities in eastern Washington, but did not provide any numerical estimates of predation rates. Coates (2001) found mammalian, avian, and unknown predation accounted for 51, 28, and 21 percent,

respectively, of 43 mortalities of transplanted CSTG in northern Nevada.

Boisvert (2002) documented 110 mortalities of CSTG in northwestern Colorado. Cause of death was reported as mammalian predators (41 percent), avian predators (33 percent), crop impaction possibly due to the radio-transmitters (4 percent), hunting (2 percent), natural mortality (2 percent, no cause given), and unknown (18 percent). Known predators of grouse in this study based on observed kills or recovery of radios were golden eagle, prairie falcon, red-tailed hawk, great horned owl, red fox, and bobcat.

Collins (2004) monitored the fate of 172 radio-marked grouse in northwestern Colorado, of which 114 were eventually found dead. Mammals were responsible for 33 percent of all deaths, avian predators accounted for 19 percent, and radio-collars for 2 percent. The remaining deaths (46 percent) were from unknown causes. Two radio-transmitters were recovered from a golden eagle nest, one from a great horned owl nest, and one from a red-tailed hawk nest. Other raptors observed at fresh kill sites included northern goshawk and Cooper's hawk. Two grouse were known to be killed by bobcats. Grouse using mine reclamation (i.e., grassland) were killed more often by avian predators, and grouse using shrubsteppe were killed more often by mammalian predators.

Most of the known mammalian predators also eat eggs of sharp-tailed grouse. Additional nest predators include striped skunk, bull snake (*Pituophis melanoleucus*), common raccoon, common raven, American crow, American magpie (*Pica hudsonia*), Richardson's ground squirrel (*Spermophilus richardsoni*), and porcupine (*Erethizon dorsatum*). Based on evidence found at the nest, McDonald (1998) concluded that common ravens and coyotes depredated the majority of unsuccessful CSTG nests in eastern Washington. In northwestern Colorado, Collins (2004) attributed 56 percent of 36 nest depredations to mammals, 6 percent to avian predators, and 38 percent to unknown predators. In a companion study of greater sage-grouse, Hausleitner (2003) reported similar findings with mammals accounting for 70 percent and birds only 5 percent of 40 nest depredations. Collins (2004) suspected two nests were destroyed by skunks, one by a bobcat, and at least 14 by coyotes or red fox.

Six of the 14 nest depredations for which Collins (2004) was unable to identify the predator involved disappearance of the entire clutch with no signs of disturbance at the nest. In no instance was the female killed. Collins (2004) suspected that snakes and/or ravens were responsible for these losses. Davison and Bollinger (2000) noted that snakes are major nest predators in grassland and shrubland cover types, but their importance as nest predators is often under-estimated. Thompson et al. (1999) documented that 88 percent of songbird nests depredated by snakes showed no signs of disturbance. Recent research using videography indicated that ravens were responsible for the disappearance of entire clutches at greater sage-grouse nests (P.S. Coates personal communication 2006). If this is also true for CSTG, then Collins (2004) under-estimated the proportion of nests depredated by avian predators.

Although nest predation rates are high, few hens are killed on the nest. Summarizing telemetry data from several studies, Bergerud and Gratson (1988) estimated 4 percent of female sharp-tailed grouse are killed on the nest. McDonald (1998) reported only two (3.7 percent) of 54 nesting attempts by CSTG resulted in the hen being killed on the nest. Coates (2001) reported that only one (5 percent) of 19 nesting hens in a transplanted population died during incubation. It was not clear whether this hen was killed on or off the nest. Of 121 nesting attempts documented by Collins (2004) in northwestern Colorado, four hens were killed away from the nest, one hen was killed by a raptor immediately adjacent to the nest, and one hen was killed on the nest.

The response of CSTG to predators varies. Sharp-tailed grouse will crouch and hide, remain motionless, fly, or run, depending on the type of predator, its closeness, and its activity (Connelly et al. 1998). Female sharp-tailed grouse will perform distraction displays by feigning injury to lure predators away from their young (Artmann 1970). When on the lek, sharp-tailed grouse are more likely to fly to escape cover in response to predators, then crouch and hide. Prairie grouse on leks tend to react more strongly to avian than mammalian predators (Berger et al. 1963, Hamerstrom et al. 1965, Sparling and Svedarsky 1978). When off the lek, the first response to predators is usually to crouch and hide and only fly if pursued.

In some cases, both on and off the lek, sharp-tailed grouse show no reaction to predators because the predator presents no immediate threat. In five encounters with male northern harriers on leks in Minnesota, sharp-tailed grouse responded once by all birds flushing from the lek, once by all birds crouching on the lek, and three times by some birds flushing from the lek (Sparling and Svedarsky 1978). In nine encounters with female

northern harriers, six resulted in all the birds flushing from the lek, one resulted in all the birds crouching on the lek, and two resulted in little or no reaction (Sparling and Svedarsky 1978). In the only documented encounter with a red-tailed hawk, all the birds flushed. Columbian sharp-tailed grouse on leks in Colorado seldom flushed in response to northern harriers unless the harrier flew directly over the lek and swooped at the grouse (R.W. Hoffman personal observation). In contrast, the appearance of a golden eagle anywhere near the lek caused the grouse to flush.

Competition

Gunnison sage-grouse, greater sage-grouse, dusky grouse, ruffed grouse, ring-necked pheasant, gray partridge (*Perdix perdix*), chukar (*Alectoris chukar*), California quail (*Callipepla californica*), and wild turkey (*Meleagris gallopavo*) are gallinaceous birds with distributions that may overlap the range of CSTG at certain times of the year. It is unknown whether CSTG directly or indirectly compete for resources with any of these species. The species most likely to encounter CSTG due to similar habitat requirements include Gunnison sage-grouse, greater sage-grouse, dusky grouse, ring-necked pheasant, and gray partridge. Of these, only Gunnison sage-grouse, greater sage-grouse, and dusky grouse occur within the range of CSTG in Region 2. Nowhere does the CSTG occur in close proximity to the congeneric greater and lesser prairie-chickens.

The range of the CSTG in Region 2 overlaps the upper limit of Gunnison and greater sage-grouse and lower limit of dusky grouse. If competition does occur, it occurs during the breeding, nesting, and brood-rearing periods when the four species may be using similar habitats and eating the same foods. Competition during winter is unlikely because sage-grouse and dusky grouse in Region 2 occupy different habitats and eat different foods than CSTG at this time of year. Even where CSTG use the same habitats as sage-grouse and dusky grouse, the likelihood of significant competition should be low because the different species evolved together and should partition habitats to minimize competition. Apa (1998) provided some evidence in support of this contention. In the only study that specifically examined niche overlap between CSTG and another sympatric grouse species, Apa (1998) reported that greater sage-grouse and CSTG in southeastern Idaho partitioned nesting habitat. There also appeared to be some niche separation in brood habitat, but not to the same extent exhibited with nest sites (Apa 1998).

Nest parasitism by ring-necked pheasants on greater prairie-chicken nests is known to occur where the two species are sympatric (Vance and Westemeier 1979). The average incubation period for ring-necked pheasants is shorter than for prairie-chickens or sharp-tailed grouse. Parasitized nests are known to contribute to the failure of greater-prairie chicken nests as the female will leave the nest with pheasant chicks before her own eggs hatch (Vance and Westemeier 1979). Columbian sharp-tailed grouse are sympatric with ring-necked pheasants in some portions of Utah, Idaho, and Washington. No instances of nest parasitism have been reported from studies of nesting sharp-tailed grouse in these states (Hart et al. 1950, Meints 1991, Schroeder 1994, Apa 1998, McDonald 1998). The probability of nest parasitism may be lower for CSTG than it is for greater prairie-chickens for several reasons. Nesting habitats of CSTG may differ from that preferred by pheasants, pheasant densities may be lower where they are sympatric with CSTG, or the timing of breeding and nesting activities may differ between pheasants and CSTG where they occur together. Reduced availability of native nesting habitats for CSTG may cause them to use cover types frequented by pheasants, such as CRP. This may increase the probability of nest parasitism.

No wild populations of ring-necked pheasants occur within the range of CSTG in Region 2, but another exotic species known to parasitize nests, the gray partridge, may eventually expand its range into south-central Wyoming and northwestern Colorado. This species has been expanding its range southward in Wyoming. Documented observations south of Interstate 80 near Rawlins, Wyoming place it within 56 to 64 km of the northern distribution of CSTG in Wyoming.

Mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), and pronghorn (*Antilocapra americana*) are common and extremely abundant in localized areas throughout the range of CSTG in Region 2. The spring through fall range of CSTG primarily coincides with the spring and summer range of pronghorn and transitional range (early spring and late fall) of mule deer and elk. The largest concentration of grouse and wild ungulates together occurs from early-April to early-May when grouse are attending leks. With the possible exception of elk, few wild ungulates share the same range with CSTG during winter in Region 2. However, mule deer and elk use the winter range of CSTG from late spring through summer and fall and into early winter depending on snow conditions. The extent to which CSTG compete with wild ungulates for resources (mainly food) is unknown. Food habit studies

of mule deer (reviewed by Wallmo and Regelin 1981), elk (reviewed by Cook 2002), and pronghorn (reviewed by Yoakum 2004) indicate that they consume some of the same foods as CSTG, suggesting competition may occur. Braun et al. (1991) hypothesized that heavy use of willow by elk in Rocky Mountain National Park may constrain breeding densities of white-tailed ptarmigan by reducing the amount of food available to ptarmigan in late winter. Ulliman (1995b) suggested that a relationship similar to the one reported by Braun et al. (1991) could occur in southeastern Idaho among mule deer, CSTG, and serviceberry. In Region 2, the impacts of elk also must be factored into this relationship. Clearly, more research is needed to document whether such a relationship exists.

Parasites and disease

Sharp-tailed grouse are hosts to parasitic arthropods (e.g., lice, mites, ticks) and helminths (e.g., nematodes, cestodes, trematodes), as well as microparasites such as protozoa, bacteria, fungi, and viruses (**Table 17**). Cases of disease and parasite infections in sharp-tailed grouse and their subsequent effects on populations are poorly documented (Peterson 2004). Most of what is known comes from studies on subspecies other than CSTG (reviewed by Tirhi 1995, Connelly et al. 1998, Peterson 2004). A review of the literature by Braun and Willers (1967) documented at least 11 species of protozoan parasites and 20 species of helminth parasites in sharp-tailed grouse. Hillman and Jackson (1973) reported consistent and heavy parasite loads in plains sharp-tailed grouse from South Dakota. Of 800 grouse examined, less than 10 were free from ectoparasites and helminths. Up to 20 species of parasites were found in a single grouse, with six to eight species usually present year-round and eight to 12 species present during the summer months. Males on leks were the most heavily parasitized group. Young collected in August and September also had heavy parasite loads. Female grouse had lower but more consistent parasite loads than males or young grouse. Parasite loads were generally lowest from December through early March. Ectoparasites were found on day-old chicks and helminths were present at two weeks of age.

Parasitic infections in sharp-tailed grouse are natural and not responsible for any substantial mortality (Edminster 1954). However, the potential for population impacts should not be dismissed (Peterson 2004). Disease outbreaks in grouse can easily go undetected (Braun et al. 1994), and there are cases where parasitic infections have been documented to impact grouse populations. For example, parasites have caused significant mortality in red grouse (*Lagopus lagopus scoticus*), a subspecies of willow ptarmigan (Hudson 1992). Naugle et al. (2004) concluded that West Nile virus significantly reduced late summer survival of some greater sage-grouse populations in the western United States and Canada. West Nile virus also has been reported to cause mortality in ruffed grouse and greater prairie-chickens (Center for Disease Control, West Nile virus avian mortality database; htpp://www.cdc.gov/ncidod/dvbid/westnile/qa/wnv_birds.htm, accessed 7 July 2006). To date, West Nile virus has not been reported in sharp-tailed grouse. This may be due to the lack of intensive monitoring of sharp-tailed grouse since West Nile virus has spread westward. Within the range of CSTG in Region 2, West Nile virus has been confirmed in several bird species from northwestern Colorado (Colorado Department of Health and Environment; http://codphe.state.co.us/dc/zoonosis/wnv/wnvhom.html, accessed 7 July 2006), including greater sage-grouse. At least one dead greater sage-grouse found in Carbon County, Wyoming also has tested positive for West Nile virus (Naugle et al. 2004).

Approximately 110 CSTG trapped in northwestern Colorado and transplanted to southwestern and north-central Colorado were tested for avian influenza, *Salmonella pullorum*, *Mycoplasma gallisepticum*, *Mycoplasma synoviae*, and *Mycoplasma meleagridis* before being released. No clinical signs of disease were apparent in any of the birds captured and all samples tested negative (Colorado Division of Wildlife, unpublished data).

Envirogram

An envirogram is a graphic representation of the proximal and distal causes/components that affect a species' chance to survive and reproduce (Andrewartha and Birch 1984). Within the envirogram model, the environment comprises everything that might influence an animal's chance to survive and reproduce. The environment consists of the "centrum" and "web". Only those things that are proximate causes of change in the animal's performance, physiology, or behavior are placed in the centrum. These are the directly acting components of the environment, such as food, cover, and predators. The centrum includes three subdivisions: resources, malentities (negative stressors in the environment), and predators. Everything else acts indirectly, through an intermediary or chain of intermediaries, to influence the components in the centrum. All the indirectly acting components are

Table 17. Reported parasites and diseases of wild sharp-tailed grouse (modified from Peterson 2004).

Group/species	State or Province (n, percent prevalence)	Reference
Mallophaga		
Amyrsidea sp.	Manitoba (218, 21)	Dick 1981
	Wisconsin	Emerson 1951
A. perdicis	South Dakota (60, 23)	Boddicker and Hugghins 1965
Goniodes sp.	Ontario	Tsuji et al. 2001
	Wisconsin	Gross 1930
G. nebraskensis	Manitoba	Emerson 1951
	Manitoba (218, 94)	Dick 1981
	Montana	Emerson 1951
	Nebraska	Emerson 1951
	North Dakota	Emerson 1951
	Ontario	Emerson 1951
	South Dakota (60, 55)	Boddicker and Hugghins 1965
Lagopoecus gibsoni	Manitoba (218, 56)	Dick 1981
L. perplexus	Ontario	Emerson 1951
	South Dakota (60, 3)	Boddicker and Hugghins 1965
	Washington	Emerson 1951
Mites		
Ornithonyssus sylviarum	Manitoba (218, 7)	Dick 1981
Unidentified	South Dakota (60, 2)	Boddicker and Hugghins 1965
Ticks		
Haemaphysalis sp.	Minnesota	Green and Shillinger 1932
H. chordeilis	Manitoba (218, 95)	Dick 1981
	South Dakota (60, 3)	Boddicker and Hugghins 1965
H. leporispalustris	Manitoba (218, 96)	Dick 1981
	Michigan	Baumgartner 1939
	South Dakota (60, 5)	Boddicker and Hugghins 1965
Hippoboscid fly		
Ornithoyia anchineuria	Manitoba (218, 16)	Dick 1981
Nematodes		
Ascaridia galli	Minnesota (53, 9)	Boughton 1937
	Wisconsin (62, 19)	Morgan and Hamerstrom 1941
Capillaria contorta	Wisconsin (126, 9)	Morgan and Hamerstrom 1941
Cheilospirura spinosa	Minnesota (53, 4)	Boughton 1937
	South Dakota (6, 17)	Boughton 1937
	Wisconsin (62, 5)	Morgan and Hamerstrom 1941
Cyrenia colini	South Dakota (6, 33)	Boughton 1937
	South Dakota (60, 62)	Boddicker and Hugghins 1965
	Wisconsin (62, 63)	Morgan and Hamerstrom 1941
Dispharynx nasuta	South Dakota (60, 5)	Boddicker and Hugghins 1965
Heterakis gallinarum	South Dakota (6, 17)	Boughton 1937
	Wisconsin (62, 31)	Morgan and Hamerstrom 1941

Table 17 (concluded).

Group/species	State or Province (n, percent prevalence)	Reference
Nematodes (continued)		
Subulura strongylina	South Dakota (6, 50)	Boughton 1937
	South Dakota (60, 52)	Boddicker and Hugghins 1965
	Wisconsin (62, 5)	Morgan and Hamerstrom 1941
Cestodes		
Choanotaenia infundibulum	Wisconsin (62, 18)	Morgan and Hamerstrom 1941
	Minnesota	Boughton 1937
Raillietina centrocerci	South Dakota (60, 62)	Boddicker and Hugghins 1965
R. variabilis	North Dakota (34, 3)	Aldous 1943
	Wisconsin (28, 4)	Gross 1930
Rhabdometra nullicollis	North Dakota (34, 9)	Aldous 1943
	South Dakota (60, 10)	Boddicker and Hugghins 1965
	Wisconsin (28, 4)	Gross 1930
	Wisconsin (62, 15)	Morgan and Hamerstrom 1941
	Minnesota	Boughton 1937
Trematodes		
Agamodistomum sp.	Minnesota	Boughton 1937
Athesmia wehri	Montana	McIntosh 1937
Brachylaima fuscatum	Alaska	Babero 1953
Echinostoma revolutum	South Dakota	Hillman and Jackson 1973
Hermatozoa		
Leucocytozoon sp.	Michigan	Baumgartner 1939
L. bonasae	Wisconsin (41, 37)	Flakas 1952
	Michigan (126, 53)	Cowan and Peterle 1957
Plasmodium pedioecetii	North Dakota (130, 41)	Shillinger 1942
	Colorado (8, 50)	Stabler et al. 1974
Trypanosoma avium	Colorado (8, 25)	Stabler et al. 1974
Haemoproteus mansoni	Unknown	White and Bennett 1979
Other protozoa		
Eimeria dispersa	Minnesota (30, 3)	Boughton 1937
E. angusta	Minnesota (39, 18)	Boughton 1937
	Wisconsin (62, 5)	Morgan and Hamerstrom 1941
Sarcocystis sp.	Alberta (76, 1)	Drouin and Mahrt 1979
Bacteria		
Francisella tularensis	Minnesota	Green and Shillinger 1932
Fungi		
Trichophyton sp.	South Dakota	Hillman and Jackson 1973

placed in the web from left to right depending on the level of their influence on the components in the centrum, with those having the most direct influence placed immediately to the left.

The envirogram developed for the CSTG is specific to Region 2 (**Figure 11a**, **Figure 11b**, **Figure 11c**, and **Figure 11d**). Some components in the web are not pertinent to other regions within the range of CSTG. For instance, mine reclamation lands are a small but important cover type used by CSTG in Region 2. This cover type is not found elsewhere within the range of CSTG. Practices applied to reclaim these lands have a pronounced influence on their value in providing food and cover for CSTG.

Conservation

Conservation Status of Columbian Sharp-tailed Grouse in Region 2

Sufficient evidence exists to suggest CSTG should be considered a subspecies of high conservation concern in Region 2. Populations have disappeared across southwestern Wyoming and western Colorado, which together encompass the historical range occupied by CSTG in Region 2. The current occupied range in south-central Wyoming and northwestern Colorado represents only 3 and 15 percent of the historical distribution in Wyoming and Colorado, respectively (Bart 2000). Further loss and degradation of habitats in Region 2 threaten the stability of the remaining population. Region 2 supports one of only two metapopulations of CSTG in the United States and the third largest population anywhere throughout the subspecies' range. Some of the largest, contiguous blocks of native habitats (i.e., shrubsteppe and mountain shrub) still occupied by CSTG are in Region 2, and previously occupied habitats within Region 2 offer the greatest potential for re-establishing populations of CSTG in historic ranges. For these reasons, and because the CSTG has been petitioned twice for federal listing as threatened or endangered (Carlton 1995, Banerjee 2004), CSTG should be considered a subspecies of special concern and afforded high conservation status in Region 2.

Threats

General

All species of grouse have strongholds in natural ecosystems (Johnsgard 1973, Storch 2000). Maintaining healthy grouse populations requires large, relatively undisturbed, natural landscapes. Whereas some grouse species can tolerate a moderate degree of habitat disturbance and can even use and benefit from artificially-created habitats, the healthiest grouse populations are associated with extensive natural landscapes exposed to natural disturbance regimes (Johnsgard 1973, Storch 2000). The CSTG is no exception. However, because the CSTG is known to use CRP fields, mine reclamation lands, and occasionally grain fields, it is considered one of the grouse with a moderate tolerance to habitat changes. Columbian sharp-tailed grouse can exist in simple or complex vegetation types as long as those cover types provide an adequate combination of food and cover. Nonetheless, it needs to be emphatically stated that CSTG in Region 2 cannot persist in artificially-created habitats alone nor can they persist on small, isolated tracts of native habitats. The fact that the subspecies has disappeared from over 90 percent of its former range is testimony enough to the importance of maintaining large expanses of native habitats in good ecological condition (**Figure 12**).

Numerous factors have been identified as threats to CSTG. These threats can be placed in one of three major categories: loss of habitat, degradation (including fragmentation) of habitat, and disturbances to populations (e.g., disease, parasites, inbreeding, hunting, other recreational activities). The two most unequivocal threats to CSTG throughout the subspecies' range are habitat loss and degradation (Hart et al. 1950, Buss and Dziedzic 1955, Marks and Marks 1987, Wood 1991, Giesen and Connelly 1993, Ritcey 1995, Tirhi 1995, McDonald and Reese 1998, Schroeder et al. 2000, Hoffman 2001, Utah Division of Wildlife Resources 2002). Much of the native habitat that remains has been altered both structurally and floristically. In some areas, these impacts have been so extensive that the few remaining unaltered habitats are often too small and widely spaced to support viable grouse populations.

Factors responsible for the loss and degradation of habitats are all human-related and include conversion of native cover types to croplands, excessive grazing by domestic livestock, herbicide treatments, fire suppression, invasion of conifers and non-native plants, urban and rural developments (including roads and utility lines), and energy development. Although the major threats have remained the same, the causes have changed over time. For example, historically, the primary cause of habitat loss was intensive agriculture; while some lands are still being converted to agricultural uses, the primary causes of habitat loss in recent years have been urban, rural, and energy development.

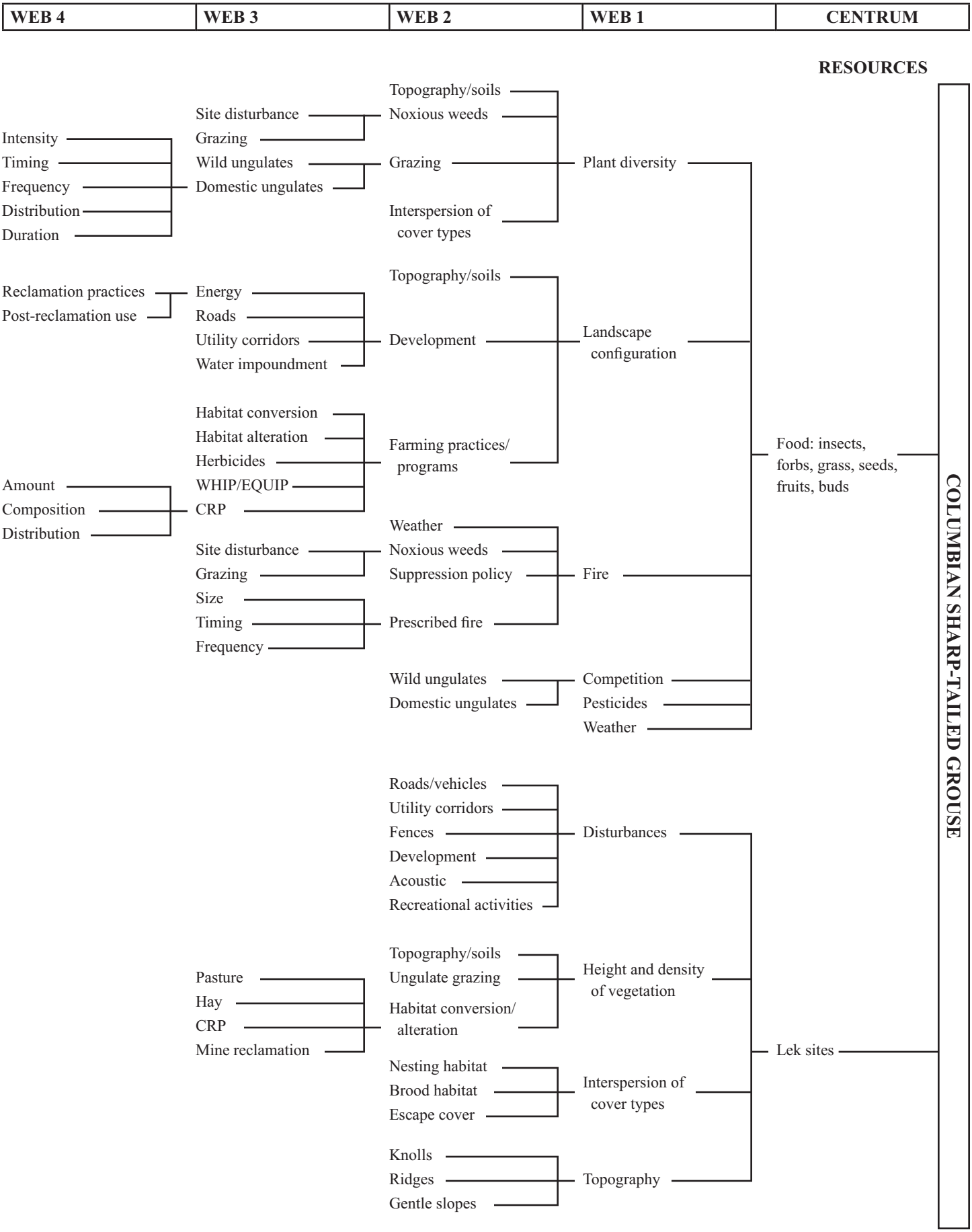

Figure 11a. Resource centrum of the envirogram for Columbian sharp-tailed grouse.

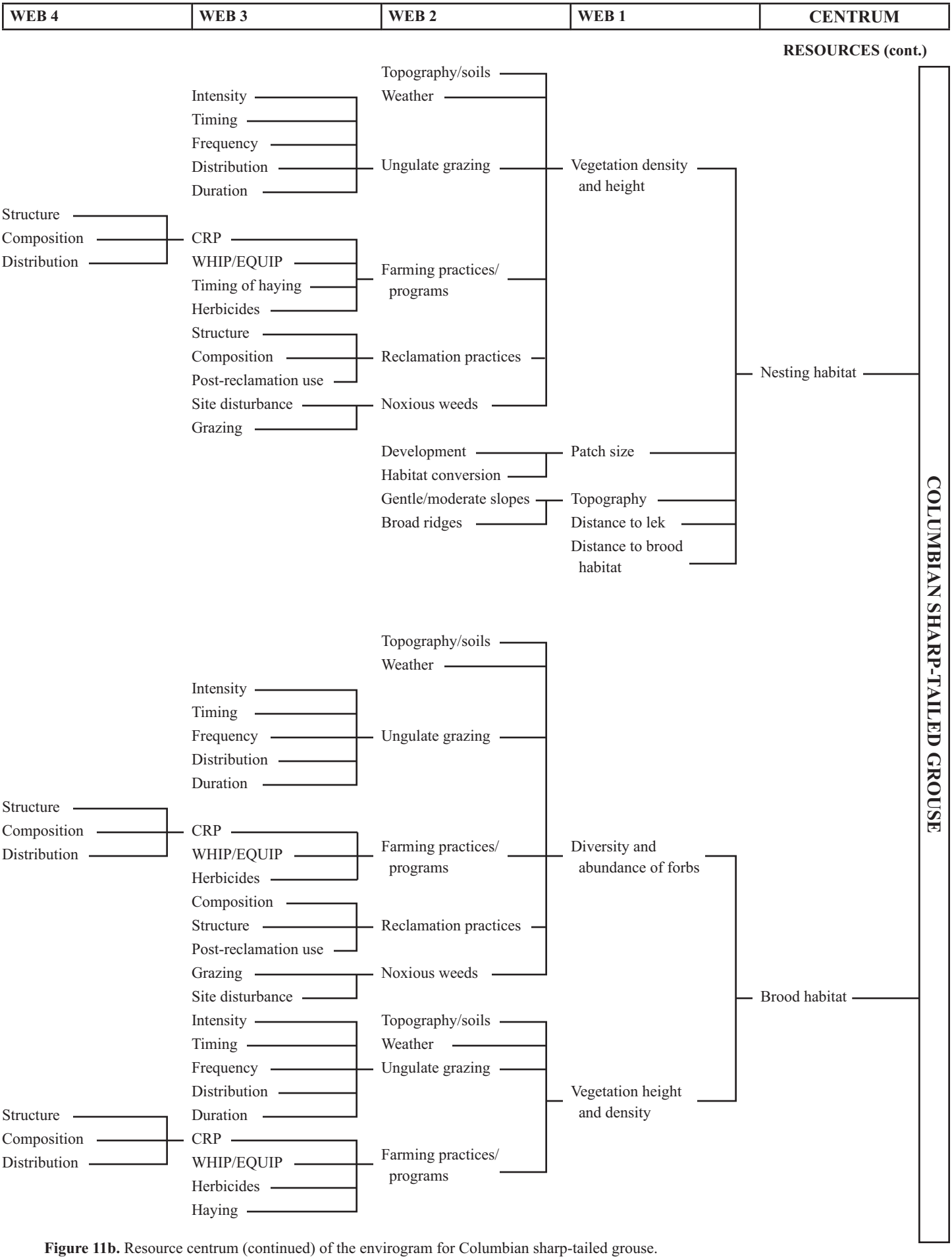

Figure 11b. Resource centrum (continued) of the envirogram for Columbian sharp-tailed grouse.

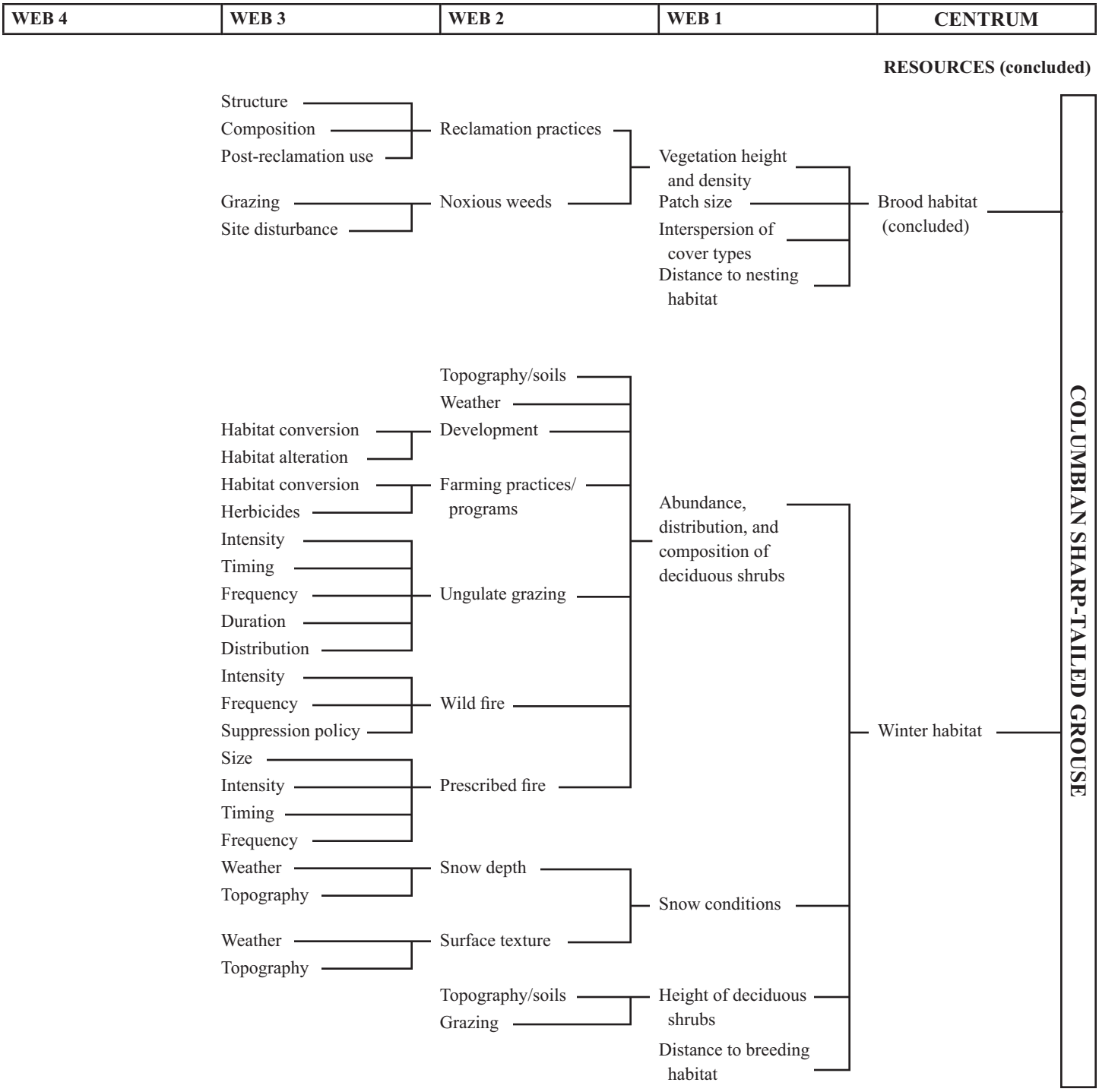

Figure 11c. Resource centrum (concluded) of the envirogram for Columbian sharp-tailed grouse.

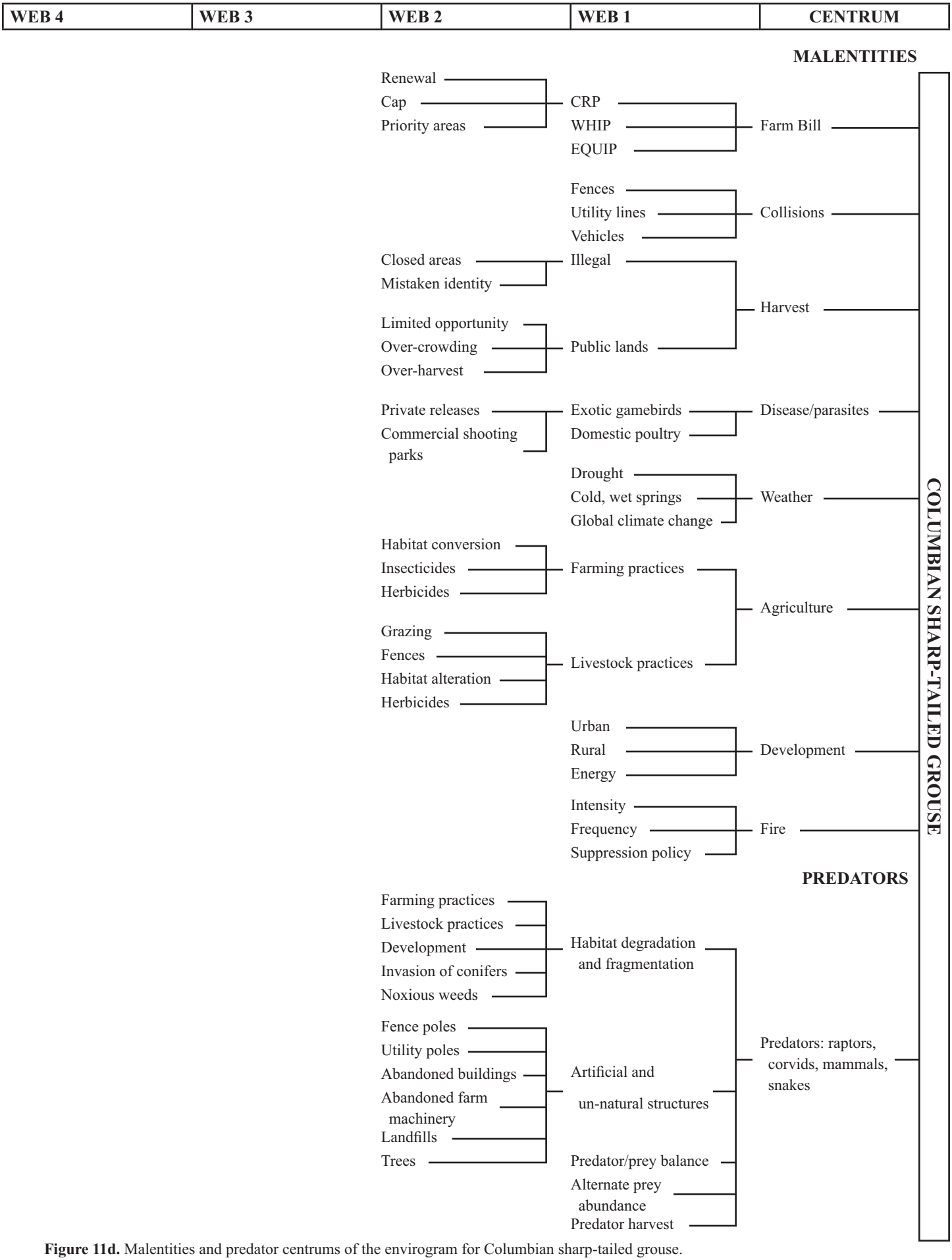

Figure 11d. Malentities and predator centrums of the envirogram for Columbian sharp-tailed grouse.

Figure 12. Maintaining large tracts of native shrubsteppe and mountain shrub cover types in good ecological condition is instrumental to long-term conservation of Columbian sharp-tailed grouse in USDA Forest Service Rocky Mountain Region. Photograph by Richard W. Hoffman.

Threats to CSTG are widespread across the subspecies' range (reviewed by Bart 2000); occur at all spatial scales; and transcend local, state, regional, and international boundaries. There are probably other factors happening now or that may happen in the future that will eventually become threats to CSTG, such as the growing interest by private landowners in establishing shooting preserves and releasing game farm birds for harvest by paying clients. In addition, there are newly identified threats, the consequences of which remain uncertain because the full magnitude of their impact has yet to occur. Examples within Region 2 include oil and gas development, West Nile virus, and global climate change. Many threats that have been identified are inter-related and synergistic in their impacts on CSTG populations and habitats. Even when threats are not related, their impacts tend to be cumulative. This makes it difficult to evaluate each threat individually and to separate and prioritize them. An attempt is made here to address the threats based on their existing severity and future potential to impact CSTG populations in Region 2. Clearly, certain threats have greater potential impacts than others do, but biologists and land managers must broaden their perspective and consider the cumulative impacts of threats to CSTG when formulating management strategies.

Oil and gas development

Oil and gas development was not identified as a major threat in the Northwest Colorado Columbian Sharp-tailed Grouse Conservation Plan (Hoffman 2001). At the time the plan was completed, much of the oil and gas activity in northwestern Colorado was outside or near the fringes of the range of CSTG, and exploration and development of new fields was occurring at a relatively slow pace. This is no longer the case. Oil and gas prices are at an all-time high. In addition, the current federal administration strongly supports more domestic oil and gas production and exploration to reduce the nation's reliance on foreign energy sources. This has prompted an increase in oil and gas development throughout the West (reviewed by Braun et al. 2002, Connelly et al. 2004). Oil and gas exploration and development have expanded into core areas within the range of CSTG in Region 2, including northwestern Moffat County, western Routt County, and south-central Wyoming. Approximately 75 percent of the occupied range of CSTG in Region 2 is designated as having medium to high potential oil and gas resources (**Figure 13**).

The Interior West supports much of the onshore oil and gas under federal and private ownership within

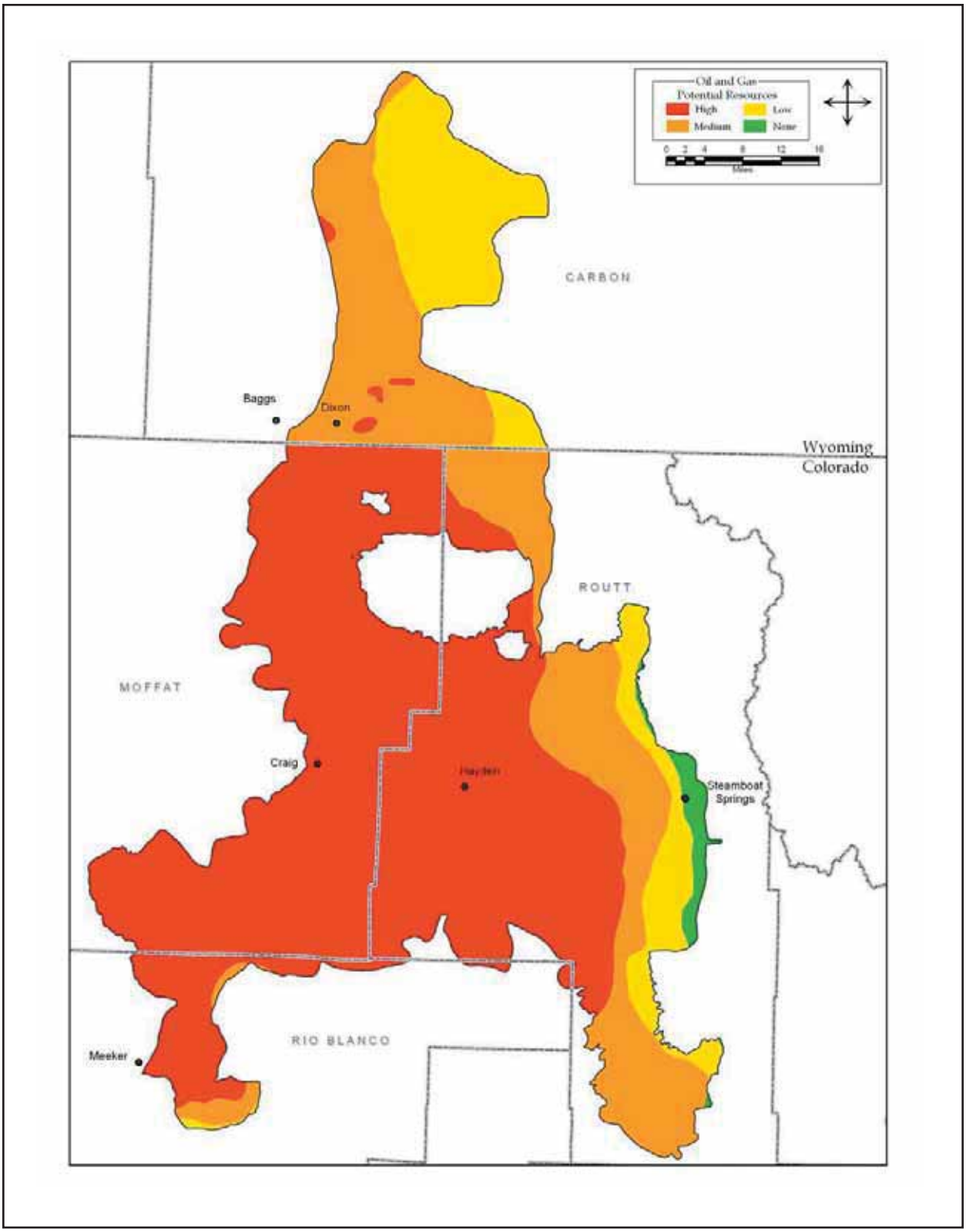

Figure 13. Potential oil and gas resources within the occupied range of Columbian sharp-tailed grouse in USDA Forest Service Rocky Mountain Region.

the contiguous 48 states. One of the major goals of the oil and gas industry is to open drilling in restricted areas, including portions of the Rocky Mountains (American Gas Foundation 2004). In recent years, a 60 percent increase has occurred in the number of permits for drilling gas wells in the Rocky Mountain West (American Gas Foundation 2005). Connelly et al. (2004) reported that from 1929 to 2004, 122,496 applications for oil and gas leases were filed with the BLM in 13 western states, of which 95.7 percent were authorized, 3.0 percent were pending, 1.2 percent were withdrawn, and less than 0.1 percent were rejected. Wyoming and Colorado accounted for 54 percent of the 122,496 applications filed with the BLM and ranked first and second, respectively, in terms of the number of applications for oil and gas leases among the eight states with existing populations of CSTG.

Connelly et al. (2004) only reported data through 2004; substantially more applications have been filed since they published their report. Their data only pertain to lands where the federal government owns the mineral rights. Lands where the mineral rights are privately owned comprise about 30 percent of the occupied range of CSTG in Region 2. This is a serious threat to CSTG because regulations governing oil and gas development on lands with private mineral rights are far less restrictive than on lands with federally owned minerals (Braun et al. 2002).

Adverse effects of oil and gas development can be divided into seven general categories:

- loss of habitat
- habitat fragmentation and isolation
- disturbance and displacement of wildlife
- physiological stress to wildlife
- introduction of predatory and competitive organisms
- direct mortality due to collisions with vehicles and utility lines
- secondary effects created by work force assimilation and growth of service industries.

Oil and gas developments are typically configured as point and linear distances scattered throughout broader areas. Collectively, the amount of habitat affected by oil and gas development may only encompass 5 to 10 percent of the landscape. However, avoidance and stress responses of wildlife may extend the influence from each well pad, road, pipeline, power line, and other facilities to surrounding habitats. Zones of negative influence may reach over 1 km on open ranges and affect use of habitats that otherwise appear undisturbed. The impacts of oil and gas developments can be especially problematic when they occur within limited areas such as crucial winter and reproductive habitats.

Braun et al. (2002) contended that all species dependent upon sagebrush and mountain shrub cover types are at risk from oil and gas developments. Until recently, the species of primary concern in Region 2 and throughout the West relative to oil and gas activity has been the greater sage-grouse (Braun et al. 2002, Connelly et al. 2004, Holloran and Anderson 2005). Beck (2006) summarized the current state of knowledge on the effects of oil and gas development and production activities on prairie grouse, relying on 11 papers that reported empirical evidence of impacts on greater sage-grouse and lesser prairie-chickens. Most of the available information deals with lek abandonment and changes in male lek attendance. Fewer studies have examined nest initiation, nest success, survival, or habitat selection. Beck (2006) cautioned that none of the reviewed studies was manipulative or *quasi* experiments from which strong inferences could be made about the impacts of oil and gas development. Most were observational or correlative studies. Despite their weaknesses, the studies resulted in some similar conclusions. Corroboration of results of several studies even under different conditions and locales is called metareplication (Johnson 2002) and provides some validity to the findings. For instance, lek abandonment near oil and gas activity has been reported for studies of lesser prairie-chickens in New Mexico and greater sage-grouse in Alberta, Colorado, Montana, Utah, and Wyoming. Each study was conducted under different conditions and used different methodology, but each reached similar conclusions, indicating that lek abandonment may in fact be related to oil and gas activity. The major findings on the impacts of oil and gas development as reported by Beck (2006) are summarized below.

Greater sage-grouse:

- In western Wyoming, fewer males recruited to leks as distance to drill rigs decreased (Kaiser 2006). No relationship was found between male recruitment and proximity of leks to main haul roads or producing wells. However, fewer males recruited to leks as distance inside an area buffered to represent

oil and gas development increased. In the same study, fewer yearling females visited leks as distance to producing wells decreased. No relationship was found between adult female visits and distance to producing wells or between adult and yearling female visits and distance to drill rigs or main haul roads.

- In northeastern Wyoming, fewer males were counted on leks within 1.6 km of compressor stations than on leks over 1.6 km from compressor stations (Braun et al. 2002). Also, fewer males were counted on leks within 0.4 km of coalbed methane wells than on leks over 0.4 km away. Growth rates based on counts were lower for leks within 0.4 km of power lines compared to leks over 0.4 km from power lines.

- In Alberta, three leks were abandoned when roads or well sites were developed within 200 m of the leks (Braun et al. 2002). The sites have since been reclaimed, but the grouse have not returned.

- In Colorado, high male counts were correlated with numbers of active and inactive wells within 3.2 km from leks. The best model included a year effect. A weak negative effect of active wells was detected in northwestern Colorado, but this effect disappeared when yearly variation was considered (Lukacs 2006).

- From 1988 to 2005, an 84 percent decline occurred in males counted on leks after coalbed methane development in the Powder River Basin of Wyoming (Naugle et al. 2006a). The largest leks were outside of coalbed methane developed areas.

- The average annual number of males counted per lek declined 44 percent on a coalbed methane developed area in Utah compared to a 15 percent increase on an undeveloped area (Crompton and Mitchell 2005). A new well caused abandonment of a lek that was 200 m from the pump jack. In the same study, survival of eight females (12.5 percent) captured in the coalbed methane area was less than survival of 11 females (73 percent) captured in the undeveloped area.

- In western Wyoming, total males counted on heavily impacted leks (>15 wells within 5 km of lek) declined 51 percent from the year prior to impact until 2004. Average annual declines were 16 percent on heavily impacted leks (excluding three centrally located leks that declined 89 percent), 19 percent on lightly impacted leks (5 to 15 wells within 5 km of lek), and 2 percent on control leks (<5 wells within 5 km of lek). These data indicate the number of males attending leks declines as the number of wells increases and that greater sage-grouse are eventually excluded from breeding within developed gas fields (Holloran 2005, Holloran and Anderson 2005). A negative change in annual lek counts was noted for leks within 5 km of drilling rigs, 3 km from producing wells, and 3 km of main haul roads. Well densities exceeding one well per 2.8 km^2 appeared to affect male attendance at leks negatively.

- In northwestern Wyoming, Lyon and Anderson (2003) reported that females from disturbed leks (<3 km from gas development) moved significantly farther to nest sites and had a lower nest initiation rate than females from undisturbed leks did (>3 km from gas development). No differences were detected in nesting success. The longer movements and lower nesting rate of females from disturbed leks were attributed to increased vehicle activity near disturbed leks.

- In Wyoming, annual survival for nesting adult females was 73 percent prior to gas development and 53 percent post-development (Holloran 2005).

- Grouse avoided coalbed methane development in suitable habitat during winter in the Powder River Basin of Wyoming (Naugle et al. 2006b).

- Avian predation of nests in western Wyoming increased from 13 to 40 percent as oil and gas development increased (Holloran 2005).

- Hatch dates averaged five days later for females that nested within an oil and gas buffered region in Wyoming compared to females that nested outside the buffer (Kaiser 2006).

Lesser prairie-chicken:

- Eighteen (45 percent) of 40 abandoned leks and only one (3 percent) of 33 active leks in southeastern New Mexico were less than 800 m from a power line (Hunt 2004).

- Road density within a 1.6 km buffer was higher surrounding abandoned (3.3 km per km^2) than active (2.4 km per km^2) leks in southeastern New Mexico (Hunt 2004).

- Abandoned leks in southeastern New Mexico had more active wells and more total wells within 1.6 km than active leks. The mean number of wells within 1.6 km was one for active leks and eight for abandoned leks during their last year of activity. Noise levels were approximately 4 decibels higher at abandoned leks that at active leks (Hunt 2004).

- Nest locations in southwestern Kansas were influenced by transmission lines, well heads, buildings, improved roads, and center-pivot irrigated fields. The nearest 10 percent of nests to each feature were farther from the feature than would be expected at random (Pitman et al. 2005).

The impacts of oil and natural gas are long-term. A typical oil and gas well has a production life of 20 years. Developed fields may expand in size as they mature, but more frequently, infill development occurs within the field. As established wells become less productive, more wells are drilled to extract the remaining resource. Thus, the initial disturbance associated with drilling may resume as the field matures. In this situation, the impacts associated with the resumption of drilling activities compound the impacts to wildlife from existing wells. Following drilling, there are more wells within the same area, which in itself may have negative consequences to wildlife.

Loss of Conservation Reserve Program land

Nearly 90 percent of the breeding, nesting, and brood-rearing habitats of CSTG in Region 2 are on private lands. Without private landowner cooperation, opportunities for protection and management of CSTG in Region 2 are limited. Changes in the way private lands are managed can have significant positive or negative impacts on CSTG populations. A prime example is the Conservation Reserve Program. This private lands program has resulted in positive population responses by sharp-tailed grouse and other prairie grouse in many portions of their range (Rodgers and Hoffman 2005). Within the occupied range of CSTG in Region 2, all CRP lands are in Colorado. These lands, which total nearly 23,000 ha, were formerly wheat fields that CSTG seldom used except for a short period in late fall and early winter following harvest (Hoffman 2001). Today, these lands support about 21 percent of the known leks and, depending on their structure and composition (Hoffman 2001, Boisvert 2002, Rodgers and Hoffman 2005), provide critical nesting and brood-rearing habitat. The conservation plan for CSTG in northwestern Colorado clearly indicates a population decline can be expected if this program is discontinued (Hoffman 2001).

No national legislation will affect CSTG more than reauthorization of the Farm Bill in 2007. Congress is considering focusing more CRP lands on wetlands protection and production of vegetation to produce ethanol; thus as contracts expire in the West, CRP acreage could be shifted to other areas of the country. Of the 23,000 ha of CRP in northwestern Colorado (Moffat and Routt counties) approximately 16,500 ha (72 percent) are due to expire in September 2007. The Farm Service Agency (FSA) recently announced it will offer certain CRP participants the opportunity to re-enroll in new CRP contracts or to extend current contracts. The FSA ranked all expiring contracts according to the Environmental Benefits Index (EBI) factors at the time of the original offer and whether the property fell within a National Priority Area. None of the National Priority Areas was in Colorado or Wyoming; consequently, few of the participants with expiring contracts will be given the opportunity to re-enroll. In Routt County, only about 7 ha of the 5,919 ha due to expire in 2007 are eligible for re-enrollment. Owners of the remaining 5,912 ha will be given the opportunity to extend their contracts for a period of two to five years depending on their EBI score. Most of these lands will only be allowed a 3-year extension. The situation is similar in Moffat County, with few contracts eligible for re-enrollment and the vast majority only eligible for a 3-year extension. This presents a tenuous situation for CSTG in Colorado. Within the next five years, most of the CRP fields that provide breeding, nesting, and brood-rearing areas for CSTG may no longer be protected. Although the new Farm Bill could change this situation, presently, the prospect for maintaining these critical habitats in the long term is in serious jeopardy.

Even if the new Farm Bill allows participants to re-enroll, it is probable that some landowners will not do so because their land has greater value for other

uses, mainly development. This is particularly the case for much of the CRP land in Routt County. These lands have high development potential due to their proximity to Steamboat Springs. The fate of other CRP lands due to expire is unknown. Some fields may be converted to crops, but it is more likely that fields with fences and water sources will be grazed. Others may be mowed for hay or plowed and replanted with more palatable grasses, and then used for hay, or grazing, or both.

Loss of CRP also may negatively impact native cover types. Due to the absence of fences, native cover types immediately adjacent to CRP are seldom grazed. Consequently, they are often in excellent ecological condition. The combination of CRP and quality native cover creates ideal habitat for CSTG. However, if the contract expires and the former CRP land is grazed, it is likely the adjacent native cover also will be grazed and even possibly treated with herbicides to increase forage production for livestock. Any of these activities will be detrimental to CSTG.

Grazing

Livestock grazing is the dominant land use on public and private lands within the occupied range of CSTG in Region 2. Livestock grazing affects soils, vegetation, and animal communities (Jones 2000). Livestock consume and alter vegetation, redistribute nutrients and plant seeds, trample soils and native plants, and disrupt microbiotic crusts (Miller et al. 1994, West 1996, Belhap and Lange 2001). These changes can lead to loss of vegetative cover, loss of herbaceous and woody species, reduced water infiltration rates, increased soil erosion, and invasion of exotic plants (Mack 1981, Tisdale and Hironaka 1981, Saab et al. 1995, Rotenberry 1998). This affects grouse populations using these plant communities in three main ways. First, high levels of grazing can reduce or eliminate key food plants for grouse. Many of these same plants also attract insects, so secondly, grazing can reduce the abundance of insects important to the growth and development of chicks. Third, grazing can lead to increased predation rates of adult and young grouse by reducing cover needed for concealment from predators. The direct effects of grazing are further compounded by actions designed to control and protect livestock, and to promote forage production for livestock. Examples of such actions include building of fences and roads, mechanical and chemical treatments of shrub-dominated communities to enhance grass production, and conversion of native plant communities to hayfields (often involving re-seeding with non-native grasses). Each of these actions can have serious implications to CSTG populations and are addressed separately from the issue of grazing.

Grazing often selectively removes highly palatable grasses and broad-leafed forbs. This alters the competitive relationship among the different species within the plant community and may tip the balance in favor of the unpalatable species. For example, heavy grazing of the herbaceous understory within sagebrush communities reduces competition and allows sagebrush plants to spread, creating dense stands with a sparse understory of annuals and unpalatable perennials (Tisdale and Hironaka 1981). These stands may be used by CSTG as escape cover, but they are usually unsuitable for nesting and brood-rearing.

The effects of livestock grazing on native shrubland habitats are complex and depend upon intensity, season, frequency, and duration of grazing, and the distribution of grazing animals across the landscape. One of the principle concerns is that livestock grazing is believed to represent an alien ecological force on shrublands of the western United States. Unlike the grasslands of the Great Plains, western shrublands had a long history where, prior to the introduction of domestic livestock, large-hoofed grazers (particularly American bison [*Bison bison*]) were rare (Mack and Thompson 1982). Even where grazing by bison was intense, it was localized and highly variable in space and time. Current grazing management plans that attempt to use rest-rotation or other forms of variable grazing to emulate natural grazing regimes are inadequate because plant communities are not given sufficient rest, and recycling of resources is dissimilar (Bock et al. 1993, Freilich et al. 2003).

The detrimental effects of intensive grazing on CSTG are frequently alluded to in the literature. Bart (2000) concluded that grazing has caused the extirpation of CSTG on approximately 75 percent of the historic range and attributed nearly 100 percent of the losses on public lands to grazing. Hart et al. (1950) identified heavy grazing as the most important factor limiting CSTG populations on non-cultivated lands in Utah. In eastern Washington, Ziegler (1979) mentioned two negative components associated with grazing: removal of nesting and brood-rearing cover, and destruction of deciduous trees and shrubs essential for winter habitat. The latter problem was not only the result of browsing, but also trampling and rubbing. A study of summer habitat use by CSTG in western Idaho indicated that CSTG selected areas least modified by livestock grazing (Marks and Marks 1987). In southeastern Idaho, Parker (1970) noted that sheep and cattle use of chokecherry

stands completely destroyed the understory vegetation and rendered the stands useless as escape and loafing cover for CSTG. Klott and Lindzey (1990) reported that of the three plant species (oniongrass, sulphur buckwheat, and snowberry) positively associated with CSTG brood sites in south-central Wyoming, two (oniongrass and snowberry) decrease with grazing. Boisvert (2002) and Collins (2004) both cautiously implied that grazing and its subsequent effect on cover needed for nesting and brood-rearing may have been a factor contributing to the lower productivity of CSTG in grazed shrubsteppe compared to ungrazed mine reclamation lands in northwestern Colorado. Hoffman (2001) considered the absence of grazing a major reason why CSTG were attracted to CRP and mine reclamation lands in northwestern Colorado. Compared to grazed shrubsteppe, CRP and mine reclamation lands supported a higher density of leks and a greater number of males per lek (Hoffman 2001). In north-central Nebraska, Flanders-Wanner et al. (2004) partially attributed higher productivity of plains sharp-tailed grouse on Valentine National Wildlife Refuge than on the McKelvie National Forest to lower grazing pressure on the refuge.

Baines (1996) conducted one of the few studies specifically designed to measure the impacts of grazing on a grouse population. Data on black grouse (*Tetrao textrx*) densities and breeding success, insect abundance, and vegetation characteristics were collected within five blocks of moorland that differed in grazing intensity. Moors with the highest intensities of grazing had on average 36 percent less vertical vegetation cover, 32 percent shorter vegetation, and supported 41 percent fewer invertebrates than measured on lightly grazed moors. The highest densities of male and female black grouse were on lightly grazed moors. Twenty percent fewer females with broods were located on heavily grazed moors, and females on heavily grazed moors reared an average of 17 percent fewer chicks than those on lightly grazed moors did. Insufficient numbers of grouse were raised on the heavily grazed moors to maintain the populations even at the lower density, suggesting that recruitment of birds from nearby moors of better quality habitat maintained populations on the heavily grazed areas.

Grazing by wild ungulates also may negatively affect CSTG habitats. Elk herds have grown dramatically due to greater protection and enforcement of game laws and lack of natural predators. Hunting has been mostly ineffective as a means of population control. The problem is not conservative regulations but the inability to achieve desired harvest levels on private lands. Elk use of sagebrush, mountain shrub, CRP, and mine reclamation lands has increased during all seasons of the year, especially where they are not hunted or only lightly hunted.

Agriculture

Cultivation has yielded some benefit to CSTG by providing additional sources of food. However, this benefit has not nearly compensated for loss and fragmentation of native habitats caused by agriculture (Hart et al. 1950). Bart (2000) reported that CSTG have been extirpated from approximately 20 percent of their historic range due to habitat loss and fragmentation caused by intensive agriculture and its associated activities. The amount of habitat lost to agriculture varies by state. In some states, habitat conversion for agriculture, more so than grazing, is the primary reason for the disappearance and decline of CSTG (McDonald and Reese 1998, Bart 2000, Schroeder et al. 2000). In eastern Washington, habitat conversion to croplands, pasture, and hay fields resulted in a decrease in native grassland and sagebrush cover types from 25 to 1 percent and 44 to 16 percent of the landscape, respectively (McDonald and Reese 1998). Mean patch size decreased from 3,765 to 299 ha for grasslands and 13,420 to 3,418 ha for sagebrush. The consequence of these changes has been a 92 percent decline in the CSTG population in Washington (Schroeder et al. 2000). The remaining population numbers less than 1,000 grouse scattered across eight small, isolated areas (Schroeder et al. 2000). Extensive conversion of shrubsteppe to croplands and grazing was identified as the major cause for extirpation of CSTG in Oregon (Bart 2000). Hart et al. (1950) reported that CSTG have been more adversely affected by the advent of cultivation in Utah than possibly any other native game bird.

Habitat losses due to agriculture in Region 2 have not occurred at the magnitude that has taken place elsewhere within the subspecies' range (Hoffman 2001). Topography, soils, and a short growing season limit the amount of land suitable for agriculture in northwestern Colorado and south-central Wyoming. These constraints are one of the main reasons why CSTG still inhabit this area.

Loss of habitat to agriculture may be partially responsible for the disappearance of CSTG from areas outside the occupied range in Region 2. Historically, CSTG occurred throughout southwestern Colorado (Rogers 1969, Giesen and Braun 1993). The last documented sighting of CSTG in southwestern Colorado was in 1985 (Giesen 1985). Giesen and

Braun (1993) hypothesized that loss of nesting and winter habitat was responsible for the disappearance of CSTG from the majority of its historic range in western Colorado. They suggested that the mid-elevation mountain shrub habitats occupied by CSTG were the same areas favored by early settlers for initial colonization and exploitation. Oyler-McCance et al. (2001) estimated that 20 percent (range = 11 to 50%) of the sagebrush-dominated cover types in southwestern Colorado disappeared between 1958 and 1993. Because much of what was once sagebrush was already gone before the oldest photographs in their study were taken, Oyler-McCance et al. (2001) emphasized that their findings represented only a small fraction of the sagebrush that has been lost in southwestern Colorado. Citing other sources (Rogers 1964, Braun 1995), Oyler-McCance et al. (2001) indicated most of the loss was related to conversion of native cover types to farmland or housing developments. This alone was not the only reason CSTG disappeared from southwestern Colorado. As habitats were lost to cultivation and development, the remaining habitats were being intensively grazed and vast expanses were being treated with herbicides to improve forage conditions (i.e., grass production) for livestock. The combined effects of these activities are what most likely caused the extirpation of CSTG in southwestern Colorado.

Urban and rural development

Human population data reported by Connelly et al. (2004) within the current and historic range of the greater sage-grouse indicated that in 1900 about 51 percent of 325 counties had less than one person per square kilometer and 4 percent had densities greater than 10 persons per square kilometer; the corresponding figures in 2000 were 31 and 22 percent. The area examined in this report includes the entire range of CSTG in the western United States. Clearly, human populations have increased within the range of CSTG. This has placed growing pressure on the landscape to provide resources to sustain and enhance human populations. Urban and rural developments by themselves remove, degrade, and fragment habitats. Highly urbanized areas present inhospitable environments to CSTG. Roads, railways, power lines, communication corridors, fences, water developments, landfills, and other facilities and activities associated with urbanization together greatly influence CSTG and their habitats.

The ecological impacts of roads only recently have been recognized and quantified (Forman and Alexander 1998). The effects of roads on wildlife include:

- increased mortality from collisions with vehicles
- modification of behavior due to habitat or noise disturbance
- alteration of the physical environment
- alteration of the chemical environment
- spread of exotic species
- increased habitat alteration and use by humans of adjacent areas (Trombulak and Frissell 2000).

The degree of impact from roads depends upon the type of road, density of roads, and proximity to key habitat use areas.

No Interstate Highways, one U.S. Highway, and seven State Highways occur within the occupied range of CSTG in Region 2. The majority of travel routes are paved or gravel county, USFS, and BLM roads. In northwestern Colorado, few (<5 percent) active CSTG leks are within 1 km of any state or federal highway, whereas nearly 70 percent occur within 1 km of a county road (Hoffman 2001, Lassige 2002). The average distance to a federal, state, or county road is 14.6, 12.1, and 1.1 km, respectively (Hoffman 2001). Approximately 6,500 km of federal (150 km), state (400 km), and county roads (5,950 km) traverse the range of CSTG in Region 2. Concerns about roads and their impact on CSTG primarily relate to construction of new roads and improvement of existing roads (Hoffman 2001). New and improved roads generally result in increased human activities. Construction of new roads has caused abandonment of leks by lesser prairie-chickens (Crawford and Bolen 1976) and greater sage-grouse (Braun 1985, Remington and Braun 1991). Collisions with vehicles accounted for 4 percent of the known mortalities of lesser prairie-chickens in Oklahoma (Patten et al. 2005). Construction of Interstate 80 in southern Wyoming was found to significantly affect the distribution of active greater sage-grouse leks within 4 km of the interstate (Connelly et al. 2004). Hoffman (2001) suggested that there may be some threshold density of roads above which CSTG avoid or reduce their use of adjacent suitable habitats.

Power lines serve as perches and nest sites for raptors and corvids (Knight and Kawashima 1993, Steenhof et al. 1993, Avian Power Line Interaction

Committee 1996). This may increase predation rates on grouse and their nests or deter use of the immediate area. Mortality rates also may increase due to collisions with power lines (Avian Power Line Interaction Committee 1994, Bevanger 1995, Patten et al. 2005). Despite these potential impacts, rigorous data on the effects of power lines on CSTG are lacking (Hoffman 2001). Lee (1936) cites a statement by an early pioneer of the Cache Valley in northern Utah who claimed that when the telegraph line was constructed through the valley, scores of sharp-tailed grouse were killed by flying into the wires. Bevanger (1995) estimated the total annual losses of capercaillie (*Tetrao urogallus*), black grouse, and willow ptarmigan to collisions with high tension power lines in Norway as 20,000, 26,000, and 50,000, respectively. Hoffman (2001) refers to unpublished data from Montana and California indicating that greater sage-grouse abandoned lek sites following construction of new power lines. Although Hoffman (2001) reported finding two active CSTG leks under utility lines, 86 percent of the active leks (n = 111) found by Hoffman (2001) were located over 500 m from any utility line.

Two coal-generated power plants occur in northwestern Colorado within the occupied range of CSTG in Region 2. Consequently, large transmission lines are a prominent feature of the landscape in this area. While raptors and corvids use these lines as perches and occasionally as nest sites, they probably are not a major risk for collisions compared to the smaller utility lines because the wires are thicker and suspended higher in the air. Of the two leks found by Hoffman (2001) under power lines, both were under large transmission lines. Despite the proximity of some leks to large transmission lines, evidence from studies of radio-marked sharp-tailed grouse suggest that they seldom use otherwise suitable habitats under or immediately adjacent to these lines for nesting or brood-rearing (Boisvert 2002, Collins 2004). Avoidance of overhead structures probably represents an innate predator-avoidance behavior.

Fences are another risk for collisions and can serve as perches for raptors depending on type of wire and posts used to construct the fence. Because of the greater surface area on top, wooden posts offer better perching sites than metal posts. Woven wire may be a greater threat than stranded wire. Both types of wire can be a problem when vegetation is allowed to grow next to the fence and thus obscure the wire. Patten et al. (2005) documented that 13 percent of the known causes of mortality of lesser prairie-chickens in New Mexico (n = 98 carcasses) and 32 percent of the documented mortalities in Oklahoma (n = 100 carcasses) were the result of collisions with fences. In the Scottish Highlands, Baines and Andrew (2003) recorded 437 collisions with deer fences involving 13 different species of birds. Red grouse, black grouse, and capercaillie formed 91 percent of all collisions. Collision rates were 1.6, 1.3, and 0.9 collisions per kilometer of fence per year for red grouse, black grouse, and capercaillie, respectively.

Many people want the amenities provided by urban areas, while enjoying the solitude, open spaces, and greater freedoms (i.e., less restrictive or no covenants) of rural living. Consequently, rural developments (i.e., ranchettes) tend to increase near urban areas. Although rural developments may continue to provide some habitats for CSTG in contrast to total urban conversion, dwellings, roads, fences, utility lines, pets, and increased human activities that are part of any development generally render the habitat of marginal value to CSTG. Studies of other prairie grouse suggest they exhibit a behavioral aversion to structures (Pitman et al. 2005). The potential consequence of such behavior is that a single home placed in CSTG habitat may effectively reduce habitat availability to a much greater distance than might superficially appear.

Most people living in rural areas own livestock, particularly horses. Thus, rural areas are often intensively fenced, and livestock are typically confined to small areas. This exerts tremendous grazing pressure on the land to the point where any native habitat becomes highly degraded and useless to CSTG. Within the occupied range of CSTG in Region 2, and especially in Routt County in northwestern Colorado, the effects of rural sprawl may actually be greater than those of urban sprawl. Sale and subsequent subdividing of ranches is an ongoing major threat to CSTG in northwestern Colorado.

Urban and rural areas and their associated landfills attract and facilitate movements and range expansion of generalist predators. Corvids, skunks, raccoons, and red fox thrive in urban and rural environments. This contributes to the spread of these predators into wildland areas occupied by CSTG, where in the absence of anthropogenic features, these predators would occur at low densities or not at all. Roads, railroads, irrigation channels, and utility right-of-ways serve as travel routes for predators, and allow them to expand their range into previously unused regions. Urban and rural areas also increase the likelihood that non-native predators (e.g., feral cats and dogs) will be introduced into CSTG habitats. In addition, rural areas may increase the probability of disease transmission because CSTG

using or passing through rural landscapes are more likely to come in contact with domestic fowl.

Pesticides

Pesticides used to control insects (insecticides) and those used to kill certain species of plants (herbicides) may have both direct and indirect impacts on CSTG. Use of herbicides has had a greater impact on CSTG in Region 2 than use of insecticides has. The Columbian sharp-tailed grouse conservation plan for northwestern Colorado did not identify insecticides as a pertinent issue (Hoffman 2001). Farmers involved in the preparation of the plan said they seldom used insecticides on their crops. The primary crop in northwestern Colorado, other than hay, is wheat. Farmers indicated that growing conditions for wheat in northwestern Colorado are marginal and profits are low. Therefore, spraying fields for insects is not economically effective. They claimed the cost per acre to spray equaled or exceeded profits they would make from the sale of the wheat crop.

Insecticides are primarily used to control insects causing damage to cultivated crops on private lands. Occasionally insecticides are used on non-cultivated lands, including native cover types, as well as cultivated crops to control outbreaks of grasshoppers and Mormon crickets. Spraying can occur on public and private lands. McEwen and Brown (1966) studied the effects of dieldrin and malathion, two insecticides used for grasshopper control, on wild sharp-tailed grouse in Montana. Sixty-three percent of 19 birds treated with dieldrin and 32 percent of 19 birds treated with malathion died within 72 hours. Lethal doses of malathion ranged from 200 to 240 mg/kg of body weight while those of dieldrin ranged from 5.0 to 32.2 mg/kg. Increased vulnerability to predators and termination of breeding were attributed to sublethal doses. Ritcey (1995) reported an instance where CSTG chicks were found dead in an area that had been sprayed for grasshoppers in British Columbia. No mention was made of the type of insecticide used or the number of birds found dead. Blus et al. (1989) document that sage-grouse in Idaho died or were severely intoxicated after feeding in alfalfa fields sprayed with the organophosphorus insecticides dimethoate and methamidophus. Intoxicated grouse could not walk or fly, were emaciated, and had diarrhea, and they likely would have died or succumbed to predation. Sharp-tailed grouse occur sympatrically with sage-grouse in the area where the dieoff was documented. However, Blus et al. (1989) did not find any dead sharp-tailed grouse or mention their presence.

The arrival of West Nile virus in CSTG range presents an additional potential problem with insecticides. Widespread use of insecticides to control mosquitoes could have detrimental effects on CSTG depending on type of insecticide used, timing of spraying, and site-specific factors such as the proximity of spraying to brood-rearing areas. Use of larvicides and adulticides with low toxicities to vertebrates, which are administered in low concentrations, can mitigate risks (Rose 2004). The organophosphate malathion has been used to kill adult mosquitoes in and around urban areas for decades. Malathion at high dosages can kill sharp-tailed grouse (McEwen and Brown 1966). However, when used to kill mosquitoes, it is administered at low (219.8 ml/ha) rates and is judged to be relatively safe for vertebrates (Rose 2004). Since sharp-tailed grouse chicks rely on insects for food during the first two to three weeks of life, regardless of the toxicity, spraying of any insecticide in brood-rearing areas must be considered detrimental.

Spraying herbicides to eliminate or reduce the shrub component and increase grass production is a form of habitat conversion. The impacts of herbicides to CSTG depend on the size of the area treated and percent vegetation kill. The larger the area treated and the greater the kill, the more detrimental it will be to the grouse. The impacts are twofold and include modification of components of the habitat required for cover and modification of components required for food. Although the woody stems of the shrubs remain after treatment, their failure to produce leaves greatly reduces their value as cover. More importantly, essential foods, such as serviceberry, chokecherry, hawthorn, and various forbs, which are usually not the target species of the herbicide treatment, are killed. Insect populations also decline after treatment due to the decline in shrub and forb abundance and diversity. Treated areas are often grazed shortly after the herbicide is applied. This further reduces the cover value of the treated area and hinders recovery of the non-targeted shrubs and forbs (Giesen and Connelly 1993).

Reseeding of ranges with forage plants is often conducted following treatment with herbicides to kill shrubs. Kessler and Bosch (1982) reported that 67 percent of reseeding operations in CSTG habitats treated with herbicides involved planting of introduced grasses. The species most commonly planted was crested wheatgrass. In Region 2, the species frequently used was smooth brome because the northern growth form is better adapted to cooler, moister conditions at higher

elevations than crested wheatgrass is (Monsen 2005). Smooth brome is a strongly rhizomatous perennial, and once established, it is extremely competitive, forming dense stands to the exclusion of other plant species. Monsen (2005) strongly cautioned that smooth brome is not compatible with native plants and should not be planted where retention of native plant communities is desired. Monocultures of smooth brome offer little in the way of cover or food for CSTG (Rodgers and Hoffman 2005).

Klott (1987) reported the abandonment of two active CSTG leks in south-central Wyoming after the surrounding area was sprayed with herbicide to remove sagebrush. He also found no use of the treated areas by sage-grouse broods. Klott (1987) concluded that the treatments were detrimental to both sage-grouse and CSTG because of the size of the areas treated and the resultant change in the composition of the vegetation. Sagebrush was completely removed and serviceberry, snowberry, and bitterbrush were severely reduced. Treated areas exceeded 160 ha in size and were primarily in the mountain shrub and sagebrush-snowberry cover types. The limited nature of these cover types and their importance to CSTG led Klott (1987) to conclude the treatments were probably more harmful to sharp-tailed grouse than sage-grouse inhabiting this area.

Fire

Fires are natural events and not universally disruptive, even though considerable vegetation disturbance may occur. The impacts of fire on CSTG habitats vary and are influenced by vegetation type and timing, intensity, frequency, and size of burns (Giesen and Connelly 1993). Additionally, the effects of fire are regional and site-specific. Fires that burn large contiguous patches of habitat may be detrimental to CSTG while fires that create a mosaic of burned and unburned areas can be beneficial. Fires in the sagebrush type have the potential to be more detrimental to CSTG than fires in the mountain shrub type because sagebrush is slow to recover following fire (reviewed by Connelly et al. 2004, Gunnison Sage-grouse Rangewide Steering Committee 2005, Monsen 2005). Several species of deciduous shrubs and trees common in mountain shrub habitats, such as serviceberry, chokecherry, Gambel's oak (*Quercus gambelii*), and quaking aspen, resprout following fire (Blaisdell et al. 1982, Kufeld 1983, Monsen 2005). In contrast, sagebrush may be eliminated or severely depleted following intense and frequent fires, and it may require decades to become re-established (Bunting et al. 1987, Miller and Eddleman 2000).

Too little as well as too much fire can negatively affect CSTG habitats. In the absence of fires, fuel loads may increase so that when a fire does occur, it may burn more intensively and over a larger area. Within mountain shrub communities, fire suppression can result in expansion and dominance of oakbrush to the detriment of species more desirable to CSTG, such as serviceberry and chokecherry. Within sagebrush and grassland communities, fire suppression can promote the invasion of two-needle pinyon (*Pinus edulis*) and juniper stands (reviewed by Connelly et al. 2004). Pinyon-juniper stands are generally considered marginal or unsuitable habitats for CSTG because they provide perches and better approach cover for raptors, and support fewer forbs and grasses than the sagebrush communities they replace. Fire suppression within sagebrush communities also can contribute to dense, late-seral, monotypic stands of sagebrush that provide little habitat for CSTG and have been postulated to be more vulnerable to widespread, intense fires (Young et al. 1979).

Historically, fire was the major disturbance factor in sagebrush and mountain shrub biomes. Mean fire return intervals have been reported as low as 10 to 20 years to as high as 150 years, depending on the site and condition and composition of the vegetation (reviewed by Connelly et al. 2004). These authors cautioned that there is currently no clear picture of the complex fire regimes that characterize the sagebrush type. Researchers disagree over the frequency and scale of fires in the sagebrush type prior to settlement, but they uniformly agree that natural fire frequencies have been greatly altered over the past 150 years due to introduction of livestock and invasion of noxious weeds (reviewed by Connelly et al. 2004). In some cases, the frequency of fire has decreased. Several studies have reported a decline in fires starting in the late 1800's. This coincides with the introduction of livestock and subsequent reduction in fine fuels needed to carry fires (Miller and Rose 1999, Miller and Tausch 2001). In other cases, the introduction and expansion of noxious weeds have contributed to an increase in fires (West 2000). Monsen (2005) suggested that natural recovery from fires is unlikely in shrub communities that have been significantly altered by grazing, planting of non-native grasses, and invasion of noxious weeds. In such areas, fires may further promote growth of noxious weeds to the detriment of native shrubs, grasses, and forbs.

Fire suppression is probably of greater concern within the range of CSTG in Region 2 than occurrence of fires that burn thousands of hectares. Lack of

deciduous shrub communities is not an issue in northwestern Colorado and south-central Wyoming (Oedekoven 1985, Hoffman 2001), but the health of these communities is of concern (Hoffman 2001). Extensive stands of dense, over-mature mountain shrub communities dominated by oakbrush are common due to lack of fire. These stands have limited value as CSTG habitat except where they border more open habitat types. Few leks occur within the mountain shrub type (Hoffman 2001). Areas selected by CSTG within the mountain shrub type during winter tend to be in more open stands dominated by serviceberry (Boisvert 2002). Grouse rarely use stands dominated by oakbrush, except as loafing and escape cover. Both Rogers (1969) and Oedekoven (1985) suggested that burning in areas of dense brush may be beneficial to CSTG in Colorado and Wyoming, respectively.

Cheatgrass (*Bromus tectorum*) invasion is a serious threat to sagebrush ecosystems in the Great Basin (reviewed by Connelly et al. 2004). Cheatgrass provides a continuous fuel source for fires. Since sagebrush is intolerant to fires, it eventually disappears from areas with extensive stands of cheatgrass as fires perpetuate the highly competitive cheatgrass. As cheatgrass increases, it becomes increasingly difficult for native grasses and forbs to persist. In some areas, former sagebrush communities have been replaced almost entirely by stands of cheatgrass. Although cheatgrass is present within the occupied range of CSTG in Region 2, it does not represent the same threat as in the Great Basin. The wetter and cooler weather in northwestern Colorado and south-central Wyoming are deterrents to establishment and spread of cheatgrass. Fires occur less frequently and tend to burn over smaller areas. However, if predictions about global climate change are correct (Bachelet et al. 2001), increasing temperatures could allow for greater spread of cheatgrass and an increase in the frequency of fire in sagebrush communities in Region 2.

Recreation

While some uses of public lands have declined, other uses have markedly increased. One such use is recreation. Today, recreational activities in the form of hiking, backpacking, camping, off-road vehicles (including snowmobiles), fishing, hunting, back-country skiing, mountain biking, horseback riding, rock climbing, nature viewing, and photography are major uses of habitats occupied by CSTG on public lands.

Hoffman (2001) suggested the cumulative impacts of increased human recreational activities may have a negative effect on CSTG, but noted no experimental research has been conducted on this subject, and evidence to support this possibility is limited to observational accounts. If recreation does impact CSTG, it may occur in four ways: (1) exploitation, (2) disturbance, (3) habitat modification, and (4) pollution (Knight and Cole 1995). Of these, disturbance is probably of greatest concern. Baydack and Hein (1987) found that during spring, male sharp-tailed grouse were temporarily displaced from leks subject to disturbance, but they continued to attempt to regain their position on the lek and returned once the disturbance factor was removed. Females avoided disturbed leks at all times and made no effort to return until the disturbance was removed. Baydack and Hein (1987) concluded that leks subject to continual disturbance may become reproductively inactive due to the absence of females. Profera (1985) conducted an experiment evaluating the distance at which greater sage-grouse on leks responded to various disturbances. The findings were inconclusive but suggested that females flushed at larger approach distances than males did and that male response was related to the number of females present (i.e., the more females that were present, the more reluctant the males were to leave).

Viewing of dancing sharp-tailed grouse on leks is a form of recreation that has been postulated to cause disturbance. Like most other forms of recreation, little research has been directed towards this topic. Studies by Baydack and Hein (1987) and Profera (1985) suggest that disturbance at leks, regardless of the source, has the most pronounced influence on females and that continual disturbance may affect reproductive performance. Hoffman (2001) did not consider lek viewing a major threat to CSTG in northwestern Colorado because over 90 percent of the leks were on private land with little or no public access, and many of the leks on public land were inaccessible during the breeding season due to road closures or snow conditions. Hoffman (2001) also noted that CSTG appear to be more tolerant of disturbance than sage-grouse, which seldom return to the lek after they are flushed. Research and management activities for CSTG in northwestern Colorado require frequent visits to leks for inventory, monitoring, capture, and marking. Leks may be flushed three or more times in a single morning during trapping operations. Blinds are placed directly on leks within a few meters of displaying grouse to closely monitor the traps. Presence of traps and blinds do not deter males or females from attending leks. When flushed, males return within 10 to 15 minutes and often sooner. Observations of banded and radio-marked females on leks that were flushed indicate that they did not return to the lek on the

same morning, but may return on subsequent mornings. Flushing CSTG from leks does not preclude other females not on the lek at the time it was flushed from visiting the lek once the males return.

Case studies of individual CSTG leks used for viewing suggest minimal impact. Annann's Twenty Mile 1 lek is located immediately adjacent to Routt County Road 27 in northwestern Colorado. This lek is well-known within the birding community and receives frequent visitors from all over the world during the spring. This lek also was intensively trapped during spring 1999 and 2000 as part of a research study (Boisvert 2002), and it is counted two to three times every year for monitoring purposes. The counts have fluctuated since 1998 from a low of 10 males in 1999 to a high of 25 males in 2001, but the long-term trend indicates stable attendance (median = 18 males, mean = 17.7 ± 4.8 males). Similar observations at public viewing leks for greater sage-grouse in northern Colorado indicate stable or increasing lek counts (reviewed by Gunnison Sage-grouse Rangewide Steering Committee 2005). Available information suggests that viewing alone does not appear to be a threat, but it may become a threat under certain situations. When viewers engage in unethical practices, such as approaching too closely or deliberately flushing birds for pictures, or where viewing is additive to other types of disturbance, it may have negative consequences.

Purchase of 4-wheel drive vehicles and other off-road vehicles including motorcycles, snowmobiles, and all-terrain vehicles for recreational purposes has increased dramatically. Flather and Cordell (1995) predicted that by 2010 the number of people in America driving motorized vehicles off road would increase 108 percent. In the past, 4-wheel drive vehicles were primarily purchased for work, with recreational use being of secondary importance. Today, 4-wheel drive vehicles are common in rural and suburban western American households. The same is true for other off-road vehicles. Manufacturing and sale of off-road vehicles is a thriving industry that continues to grow. Although off-road vehicles are used for many purposes, their primary use is recreational. Off-road vehicles, other than motorcycles, are relatively recent forms of motorized transportation that have facilitated use of areas previously inaccessible to most people. The classic example of an off-road vehicle that has permitted this to happen is the snowmobile. Snowmobiles first appeared on the commercial market in 1962. In 1969, 290,000 snowmobiles were placed on the consumer market (Doan 1970). By 1974, snowmobile sales had grown 2,500 percent, with nearly 400 models produced by over 50 different companies (Ives 1974).

The extent of use and damage caused by 4-wheel drive and off-road vehicles in areas occupied by CSTG has been poorly documented. Erosion, slumping, soil compaction, vegetation damage, noise pollution, and harassment of wildlife have all been identified as environmental impacts of off-road vehicles (reviewed by Lodico 1973). The snowmobile perhaps more than any other off-road vehicle presents the greatest threat because it offers supreme mobility to humans at a time when many animals are least mobile. Frequent use of any off-road vehicle in areas occupied by CSTG may be an issue. Flushing of birds may increase their vulnerability to predators, unnecessarily cause them to expend energy, or temporarily displace them from optimal feeding, loafing, roosting, nesting, or breeding sites.

Coal mining

Coal is presently the major resource extracted from the landscape within the occupied range of CSTG in Region 2, but this may change as oil and gas resources are developed. Three companies mine coal within the range of CSTG in Region 2. All operate in northwestern Colorado. Surface mining has been the primary means of extraction, but one large operator has switched to underground mining. Coal mining has disturbed less than 1 percent of the landscape within the occupied range of CSTG in Region 2 and, in the long-term, it appears to have benefited CSTG in northwestern Colorado (Hoffman 2001, Boisvert 2002, Collins 2004). However, activities associated with coal mining have been identified as potential threats to CSTG, including construction of roads, power lines, railroads, buildings, and other ancillary facilities.

Reclamation practices on surfaced mined lands have improved dramatically over the past three decades due to the passage of the Surface Mining Control and Reclamation Act (SMCRA) of 1977. Boisvert (2002) found no use by radio-marked CSTG of areas mined prior to the passage of this act. In comparison, Boisvert (2002) and Collins (2004) documented extensive use during the breeding, nesting, and brood-rearing periods of lands reclaimed following the guidelines of SMCRA. Boisvert (2002) and Collins (2004) presented productivity data suggesting lands reclaimed following passage of SMCRA provided superior habitat conditions compared to native cover types and CRP, particularly for brood-rearing.

Coal mining displaces CSTG in the short term as nearly all vegetation is removed where mining occurs. Once the area is reclaimed, active leks may reappear within 10 to 15 years. Grouse may start to use the area sooner depending on the reclamation seed mixture and growing conditions (i.e., timing and amount of precipitation).

Reclamation guidelines have changed little over the years, but practices used to achieve standards set forth by the guidelines have evolved. Initially, mine operators had minimal experience in restoring plant communities. Early reclamation practices were primarily designed to control erosion and consisted of replacing the topsoil, constructing diversion ditches where needed, and seeding. Seed mixtures mainly included non-native grasses, forbs, and shrubs that were cheaper to purchase than native seed mixes. Seeds of many native species, especially forbs and shrubs, were not available, and little information existed on how to establish native species. Substantially more information and experience were available on how to establish several different species of non-native grasses and forbs. Rangeland reseeding programs using smooth brome, crested wheatgrass, intermediate wheatgrass, and alfalfa were frequently conducted by private landowners, USFS, and BLM. These non-native species were attractive to mine operators because they were easy to establish and, most importantly, became established quickly, which was considered essential for controlling erosion.

While mine operators achieved some success establishing non-native grasses and forbs, they had minimal success establishing shrubs. The common practice was to drill shrub seeds into the soil along with grass and forb seeds. Few shrubs were successfully established using this approach. Grasses and forbs usually outcompeted shrubs, especially where more aggressive non-native grasses were planted. In many areas, the most abundant shrub on the landscape prior to mining was big sagebrush. Mine operators excluded this species from seed mixtures because it was considered undesirable from a rangeland perspective. Thus, the primary outcome of early restoration efforts was the conversion of sagebrush and mountain shrub dominated communities to grasslands dominated by non-native grasses. Wildlife managers viewed this outcome as being negative for wildlife.

Considerable changes have occurred in reclamation practices since passage of SMCRA. Seeds of native species are now readily available on the commercial market at reasonable prices, and research studies have provided valuable information on how to establish native grasses, forbs, and shrubs (Monsen 2005). Boisvert (2002) and Collins (2004) each identified over 90 different species of grasses (25 species), forbs (59 to 61 species), and shrubs (7 to 11 species) in mine reclamation lands used by CSTG in northwestern Colorado. Approximately 50 percent of the identified plants were native species. Not all species identified were part of the original seed mixtures, indicating natural colonization had occurred on the reclaimed sites, particularly by forbs.

The greatest potential threat to CSTG with respect to mine reclamation lands is what will happen to these lands over the long term after bond release (Hoffman 2001). Regardless if the mines retain ownership or the lands are sold or revert to the original owners, there are no guarantees to assure these lands will be managed in ways that are beneficial or at least not detrimental to CSTG. In most cases, reclaimed lands that have received bond release are leased for grazing. The possible detrimental impacts of grazing and its associated practices (e.g., fencing and herbicide treatments) have been previously addressed. Impacts of most concern are reduction of residual cover important for nesting in spring, reduction of new herbaceous growth during late spring and summer important for nesting and brood-rearing, and reduction or loss of desirable forbs important as food and as a source of insects for chicks. Also of concern is the spread of noxious weeds. Of the 90 different plant species identified on mine reclamation lands by Boisvert (2002) and Collins (2004), at least 10 were classified as invasive, undesirable species. At the time these studies were conducted, no invasive species were threatening established plant communities within the areas still under bond (i.e., no grazing). This was due, in part, to an aggressive weed control program by the mine operators. Another reason was that healthy plant communities already established on these areas kept the weeds from spreading. Any significant alteration of these communities, whether due to improper grazing or some other form of disturbance, may promote the spread of noxious plants on mine reclamation lands.

Hunting

Hunting is a form of recreation that results in direct disturbance and exploitation of CSTG. Currently, CSTG are legally hunted in Colorado, Utah, Idaho, and British Columbia. Hart et al. (1950) identified unregulated hunting as one of the major contributing factors leading to the decline of CSTG. Tirhi (1995) reported that regulated hunting likely has little effect on the stability of healthy CSTG populations. At the

other extreme, Marks and Marks (1987) and Ritcey (1995) cautioned against allowing hunting of small, isolated populations. In Utah, populations continued to decline despite a closed season for 25 years (Hart et al. 1950). Likewise, closed seasons in Washington (Tirhi 1995), portions of Idaho (Marks and Marks 1987), and Wyoming (Oedekoven 1985) have not resulted in recovery of populations in these areas. Hoffman (2001) provided data indicating that hunting removed less than 4 percent of the fall population in northwestern Colorado. At this level of harvest, Hoffman (2001) considered hunting mortality was compensatory to natural mortality, but suggested overharvest may occur on public lands.

Bergerud (1988b) argued that hunting at any level may be additive to over-winter mortality of grouse. Several other investigators have presented data indicating that hunting of grouse is partially, if not totally, additive to natural mortality (Braun 1969, Ellison 1991, Small et al. 1991, Steen and Erikstad 1996, Smith and Willebrand 1999). Ammann (1957) concluded that prairie sharp-tailed grouse in Michigan could sustain a harvest of 40 to 50 percent of the fall population on large areas of optimum habitat during naturally increasing or stable population trends. In contrast, Amman (1957) reported that on isolated areas of limited size or on areas with below optimum habitat where populations were declining, hunting depressed populations to a greater extent than would naturally occur without hunting.

The argument that if hunting is additive, then subsequent breeding populations should decline is not valid. Immigration from non-hunted or lightly hunted areas may sustain densities on some heavily hunted areas (Small et al. 1991, Smith and Willebrand 1999). As a result, effects of hunting may go undetected or hunting may be interpreted as having no impact because breeding densities remain stable. This may be happening on some public hunting areas in northwestern Colorado.

Public hunting opportunities for CSTG in northwestern Colorado are limited due to the preponderance of private lands. Hoffman (2001) suggested that this may result in overharvest in the few areas where CSTG occur on public lands. Giesen (1997) reported that California Park accounted for approximately 30 percent of the total CSTG wings collected in northwestern Colorado from 1981 to 1997. California Park is one of the few places in northwestern Colorado where CSTG occur on USFS lands during the fall hunting season. Many hunters using this area are familiar with the habits of the birds and know how and where to look for them. USFS personnel responsible for management of this area have expressed concern about possible overharvest of this population (R.C. Skorkowsky personal communication 2005). No data are available to support or refute this concern. Counts of known leks in California Park have shown no long-term decrease or increase in the population (Colorado Division of Wildlife, unpublished data). However, as reported by Small et al. (1991) and Smith and Willebrand (1999) for other species of grouse, it is possible the California Park population and other heavily hunted populations on public land are maintained by immigration of birds produced on surrounding private lands.

Another reason for concern about overharvest on some public lands, such as California Park, is that not all public lands in northwestern Colorado open to hunting are accessible to the public or support CSTG. Some of best habitats for hunting CSTG on BLM lands are surrounded by private holdings and cannot be accessed by public hunters. Many of the BLM lands that are accessible to the public are at lower elevations within the sagebrush zone. These areas support low densities of CSTG and provide marginal hunting opportunities. Leasing of State Trust Lands by the CDOW since 1993 has provided additional areas for the public to hunt CSTG. This has alleviated some pressure on the more heavily hunted federal lands. However, CSTG on the better-known State Trust Lands may now be subject to overharvest.

Climatic factors/global climate change

All species of grouse are sensitive to annual fluctuations in weather conditions. Weather (Shelford and Yeatter 1955, Yeatter 1963) and vegetation production (Kirsch et al. 1978) are two of the foremost factors influencing production of prairie grouse. Of these two factors, weather probably has the single most pronounced influence because it also affects vegetation production. Weather can affect grouse production in three primary ways:

- by decreasing nest success and chick survival due to poor cover
- by decreasing food availability due to lack of forbs and insects
- by direct mortality of chicks due to chilling or heat stress.

The effects of weather on grouse populations are multifaceted, which is why attempts to show a relationship between a single weather variable and production indices often fail. Such simple associations do not adequately address the complex relationships among numerous weather factors that influence grouse production (Flanders-Wanner et al. 2004).

Northwestern Colorado and south-central Wyoming can experience extreme climatic conditions during all seasons. While the avifauna present in this region is adapted to these conditions, adverse effects can occur during prolonged periods of below or above average precipitation and temperatures. Cold, wet springs that coincide with the peak of hatch can decrease production. On the other hand, if above average moisture occurs before hatching, the resulting increased vegetation growth needed for cover and food can enhance grouse production. Bergerud (1988a) reported that productivity of sharp-tailed grouse in North and South Dakota was positively correlated with an index to soil moisture. Collins (2004) reported that severe drought conditions during 2002 contributed to low nesting success and poor chick survival of CSTG in northwestern Colorado. The effects of the drought differed between cover types. Brood success and chick survival in mine reclamation declined from 2001 (moderate drought) to 2002 (severe drought). Brood success and chick survival remained low during both years in shrubsteppe, suggesting that within this cover type these reproductive parameters may have been affected by the moderate as well as the severe drought more than in mine reclamation. In north-central Nebraska, May average temperature, June average temperature, and cumulative precipitation from 1 January to 31 July were positively correlated with sharp-tailed grouse production, while June number of heat stress days and June number of days with precipitation over 2.54 mm were negatively correlated with production (Flanders-Wanner et al. 2004).

The impacts of weather on sharp-tailed grouse production are beyond management control. Naturally-occurring weather extremes are to be expected and generally only have temporary impacts on grouse populations. Species, such as sharp-tailed grouse, with high reproductive rates can quickly recover from extreme weather events. However, for small, isolated populations living in marginal habitats, the effects of weather may be more severe and long-lasting.

Not all weather-related events that affect grouse may be the result of natural weather phenomena. Global climate change is a major conservation concern that is predicted to affect the structure and functioning of ecosystems worldwide (McCarty 2001, Walther et al. 2002, Parmesan and Yobe 2003, Krajick 2004). These studies emphasize that additional threats will emerge as climate continues to change. The new threats will be most pronounced where climate interacts with other threats such as habitat degradation and fragmentation. Although the effects of climate change have yet to be rigorously demonstrated, available data suggest that the prudent course of action is to take the effects seriously (McCarty 2001).

Future climate scenarios show two prominent features in the West: increases in temperature, hence a decrease in frosts; and increases in precipitation (Bachelet et al. 2001). Increases in temperature are predicted to have a long-term impact on species composition of the shrubland ecosystem. Temperature increases will likely move the frost line north, allowing frost-sensitive species of the southwest to move north and displace the cold-adapted species growing in the shrubland ecosystem (Neilson et al. 2005). Models further predict that increases in precipitation will produce dramatic increases in woody (i.e., conifers) expansion at the expense of shrublands (i.e., sagebrush and mountain shrub) throughout the Interior West, and a corresponding increase in fire due to increased fuel loads (Neilson et al. 2005). The increase in fire does not contradict the expansion of conifers because fires will not occur everywhere at all times. Sufficient fire-free intervals will exist for conifer establishment. The timeline for these predicted changes to occur is unknown as are the consequences to CSTG. However, human mismanagement of habitats occupied by CSTG could compound and accelerate the effects of climate change.

Management Activities for Columbian Sharp-tailed Grouse in Region 2

Implications and potential conservation elements

Loss of CRP is the most important immediate threat to CSTG populations in Region 2. One of the primary reasons the USFWS did not list the CSTG as threatened or endangered in 2000 was because three states, including Colorado, provided evidence that populations were stable or increasing due to the implementation of the Conservation Reserve Program. In their 12-month finding, the USFWS specifically discusses the importance of CRP to CSTG and partially justified not listing the CSTG because they concluded CRP lands were relatively secure until 2008 to 2010

when the contracts would expire (U.S. Department of Interior 2000). Failure to recognize the precarious nature of the Conservation Reserve Program was short-sighted on the part of the USFWS. The USFWS acknowledged that if CRP lands important to smaller populations of CSTG reverted to crop production or were significantly altered in other ways (i.e., grazing or haying), this would greatly increase the risk of extirpation. However, they did not believe the larger metapopulations were in danger of extirpation and suggested these populations would not be adversely affected by loss of CRP. Although these populations should persist without CRP, the available data suggest they would experience drastic declines, especially in states such as Utah where native cover types are limited in distribution and degraded due to excessive grazing (Utah Division of Wildlife Resources 2002). Population declines also can be expected to occur in Colorado, Washington, and Idaho. That CSTG are so dependent on an artificial cover type that can be eliminated with a change in the farm program is reason for concern and emphasizes the need to protect, enhance, and restore native cover types important to CSTG. This was a major premise of the second petition that was filed to list the CSTG (Banerjee 2004).

It is anticipated that within the next three to five years, oil and gas exploration and extraction could be the single most threatening activity on lands occupied by CSTG in Region 2 if these resources are developed to their fullest potential. Compared to the coal industry, regulations governing the oil and gas industry are less restrictive and inadequate to insure proper reclamation and compliance with environmental concerns. The ability to enforce existing laws and personnel to make enforcement effective are lacking. Because the situation changes over time, there is no easy way to predict the extent of disturbance on the landscape from oil and gas activity and to develop effective mitigation and restoration measures. The oil and gas industry has adopted a policy to mitigate impacts to wildlife, but participation is voluntary. Furthermore, even though oil and gas companies are required to post bond when removing federally owned minerals, bonds may be insufficient to insure that disturbed sites are fully reclaimed. Companies may change ownership, or larger companies may sell their leases to smaller companies. Thus, it is not clear who is liable for reclamation. There is also concern that if small companies purchase the leases, they may have insufficient means to restore the landscape. Over the long term, it may be cheaper for companies to forfeit their bond money than to complete reclamation. Finally, the regulatory agencies in Colorado and Wyoming responsible for overseeing the oil and gas industry (Oil and Gas Commission) are mandated by law to promote oil and gas resources in their respective states. This conflict of interest seriously hampers the regulatory process. An agency responsible for promoting energy development cannot at the same time effectively protect public health, safety, and welfare, which includes protecting other resources (e.g., wildlife) that may be impacted by oil and gas activity.

On their website (http://oil-gas.state.co.us/general/typquest.html, accessed 4 November 2006), the Colorado Oil and Gas Commission claims that impacts of oil and gas development on wildlife are relatively small and benign because a well only affects an area of approximately 1 ha. The Commission fails to address the impacts of multiple wells and associated infrastructure (roads, power lines, pipe lines, compressor stations, collection stations) required to maintain wells and to move the product to market. They report that CDOW wildlife biologists have confirmed that gas wells developed at one well per 16 ha (40 ac) typically have less impact on wildlife than 14 ha (35 ac) ranchette developments. This comparison is an attempt to minimize the impacts of oil and gas development by comparing it to another type of development that is known to have serious impacts to wildlife. Wildlife managers presently do not have rigorous data to support their concerns about oil and gas development. Consequently, the oil and gas industry has proceeded with developments using the argument that there are no data to conclusively demonstrate negative effects to wildlife. The burden of proof has fallen on wildlife and land management agencies. If the oil and gas industry truly believes their activities have no impacts to wildlife initially or in the long term, they should assume the responsibility of collecting data to support their contention (Braun et al. 2002).

Historically, unregulated and widespread grazing posed the greatest threat to CSTG in Region 2. Data obtained from the National Agricultural Statistics Service indicate that over the long term (50+ years), both sheep and cattle numbers have declined in counties where CSTG still occur in Region 2. Despite the overall reduction in domestic livestock, grazing remains an issue of concern in Region 2. Few areas within the occupied range of CSTG in Region 2 are not grazed, especially on public lands, and basically no effort has been made to rest formerly overgrazed ranges. Consequently, the effects of past grazing practices are still evident throughout Region 2. Ungrazed rangelands encompass less than 20 percent of the occupied range

of CSTG in Region 2, and critically important habitats continue to receive excessive grazing pressure to the detriment of CSTG.

Having the option to alter grazing patterns from year to year would alleviate some of the problems associated with grazing. However, most CSTG habitats in Region 2 are snow-bound from December through March. Therefore, most grazing pressure on habitats occupied by CSTG in Region 2 occurs during the growing season and continues into the fall (i.e., from mid-May through mid-September). Thus, livestock are on the range every year during the critical periods when CSTG are nesting and raising their broods.

Livestock grazing is perhaps the most contentious, politically sensitive, and polarizing issue facing those responsible for management and conservation of prairie grouse in North America. The debate centers around the lack of empirical data on effects of grazing on grouse. There are no published studies on the effects of livestock grazing on CSTG based on manipulative experiments designed to measure cause-effect relationships. However, extensive information does exist on impacts of grazing on plant communities (i.e., sagebrush and mountain shrub) of critical importance to CSTG (reviewed by Saab et al. 1995, Trimble and Mendel 1995, Connelly et al. 2004, Gunnison Sage-grouse Rangewide Steering Committee 2005, Monsen 2005). This information has been used for making inferences about the negative impacts of grazing on CSTG (Hart et al. 1950, Parker 1970, Zeigler 1979, Klott 1987, Marks and Marks 1987, Giesen and Connelly 1993, Tirhi 1995, Schroeder et al. 2000, Hoffman 2001, Utah Division of Wildlife Resources 2002). In surveys conducted by Miller and Graul (1980) and Kessler and Bosch (1982), respondents identified past and present overgrazing as the highest ranking factor suppressing CSTG populations.

With regards to grouse management, grazing can be a compatible and acceptable use of the landscape when done properly. Private lands provide the majority of CSTG habitats in Region 2. The primary use of these lands is for grazing. Healthy and productive rangelands are the foundation for both abundant wildlife and a profitable and sustainable ranching industry. Emphasis should be placed on maintaining these lands as viable economic units to preserve large areas of habitat for CSTG. The alternative is habitat fragmentation and increased human impacts when rangelands are sold for development.

In the past, conversion of native habitats for other uses, particularly croplands, was considered the second greatest threat to CSTG in Region 2. Due to topographic constraints, habitat conversion for agricultural purposes has had less of an impact on CSTG populations in Region 2 than elsewhere throughout the subspecies' range (Hoffman 2001). The loss of habitat to agriculture in portions of Region 2 has been partially and temporarily alleviated because extensive areas of cropland have been converted to CRP (Hoffman 2001, Rodgers and Hoffman 2005). Hoffman (2001) estimated that agricultural lands (primarily wheat, alfalfa, and hay) comprise about 18 percent of the occupied range of CSTG in northwestern Colorado. The proportion of agricultural lands within the range of CSTG in Wyoming is less than 5 percent. The difference is due to the absence of wheat farming in south-central Wyoming. Unlike in Colorado, cultivated land in Wyoming is generally restricted to areas adjacent to river bottoms with little upland tillage. Further conversion of native habitats to croplands is not expected to occur in Region 2, but habitat loss is likely to occur because of other activities, including urban and rural expansion and energy development.

Rosenberg et al. (2004) estimated recreational use on lands administered by the USFS has increased 76 percent since 1976. Former USFS Chief Dale N. Bosworth identified unmanaged recreation as one of the four major threats to the health of the nation's forests and grasslands (www.fed.us/projects/four-threats, accessed 9 October 2006). There is no evidence to suggest that present levels of recreation are affecting CSTG populations in Region 2, except possibly in localized areas. Of concern, however, is that the level of activity will continue to increase, and that conflicts between recreationists and wildlife will escalate in Region 2. The many types of recreational activities are in themselves a problem. Managers have the difficult task of trying to regulate the many different ways people recreate. It is much easier to focus on one group as evidenced by the recent proposed regulations to manage off-road vehicle use on national forest and grasslands (U.S. Department of Agriculture 2004). Recreational activities such as skiing, hiking, and off-road vehicle use may cause minimal or only localized conflicts with wildlife, but their combined effects may cause significant disturbance or habitat degradation. Managing one form of recreation to minimize conflicts with wildlife without simultaneously considering the other types of recreation occurring in the area may not solve the problem.

People with more expendable income and leisure time will continue to move into Region 2 and will be seeking new and different ways to recreate. This will place additional demands on the limited amount of public lands within the occupied range of CSTG in Region 2. Since sagebrush and mountain shrub communities in Region 2 support a diverse array of wildlife species, including three species of grouse, they are becoming a popular destination for ecotourism, a form of organized recreation that brings tourists to biologically rich and unique ecosystems. Presently, at least nine different commercial tours visit northwestern Colorado each spring to observe CSTG on leks.

The threat of overharvest of CSTG on public lands may become more widespread and pronounced as human populations grow and opportunities diminish for hunting other grouse species. Whether hunting impacts the rate of growth of CSTG populations remains a subject of debate. It is not known to what extent fall hunting is compensatory or additive to natural mortality. Sharp-tailed grouse are short-lived, lay large clutches, attempt to nest as subadults, and are relatively good re-nesters; these traits suggest that hunting may be more compensatory than for longer-lived and less productive galliforms, such as Gunnison and greater sage-grouse. However, this situation may only apply to healthy populations distributed over large areas of optimum habitat. Columbian sharp-tailed grouse in Region 2 are not as widely distributed as they were historically, and conditions in the remaining native habitats may be less than optimal. What effect this may have on the impacts of hunting is unknown. Given the declines in CSTG populations and distribution throughout its range, Carlton (1995) and Banerjee (2004) challenged the justification for the continued sport hunting of this subspecies of sharp-tailed grouse.

Global warming should be recognized as a serious threat to the long-term persistence of CSTG in Region 2 and throughout the subspecies' range in western North America. Global climate change could have consequences on a larger scale than the combined effects of all the other activities threatening CSTG. The critical issue is no longer if global warming is occurring, but rather how to slow and eventually reverse its effects on wildlife and the plant communities upon which they depend. Climate research throughout the world suggests that global warming will likely continue for decades even if steps are taken now to address the problem.

Global warming, energy development, rural and urban expansion, fire suppression, recreation, and most of the other activities identified in this assessment as threats to CSTG are symptoms of the much greater problem of human population growth. The human population in the United States recently surpassed 300,000,000 people. Burgeoning human populations are placing an increasing demand on the landscape for more resources, ways to make a living, places to live, and places to recreate. Addressing the human population issue is beyond the scope of this assessment, but failure to mention it perpetuates the illusion that ways can be found to maintain wildlife populations and their habitats in spite of growing human populations. Regardless of scientific and technological advances, wildlife habitats will continue to decline and sustain irreparable damage if human population growth is not managed.

One only needs to review the conservation status of grouse in Europe and Asia (Storch 2000) and the history of the heath hen (*Tympanuchus cupido cupido*) on the Atlantic coast and Attwater's prairie-chicken (*T. cupido attwateri*) on the Gulf coast (Johnsgard 2002) to predict the fate of grouse elsewhere in North America if human populations continue to grow. This is not a criticism of those responsible for conservation and management of grouse and their habitats. The wildlife profession has tried to bring attention to this matter, but to no avail (see position statements by The Wildlife Society on human populations and economic growth at http://.wildlife.org, accessed 4 December 2006). Columbian sharp-tailed grouse are in the direct path of growth and development. Unless the situation changes, to expect that wildlife managers can develop strategies to increase or even maintain CSTG populations at their present levels is wishful and irrational thinking. The best that can be expected is to prevent the subspecies from becoming extirpated and to retain a few viable populations on the landscape. This is the management approach for CSTG in several western states and has been the management strategy for black grouse and capercaillie in many countries in Europe for several decades (Storch 2000).

Tools and practices

Inventory and monitoring populations

Tirhi (1995) listed six survey methods used for monitoring sharp-tailed grouse populations: lek counts, lek surveys, dropping counts, strip census, brood surveys, and winter counts. Three additional survey methods not discussed by Tirhi (1995) are lek routes (Connelly et al. 2003), wing collections (Giesen 1999), and lek densities (Cannon and Knopf 1981).

Lek counts: Lek counts are an enumeration of the number of grouse identified on leks. They provide information on total and average number of males per lek and total and average number of birds per lek. Lek counts are best conducted from ½ hour before sunrise to 2 hours after sunrise during the peak of breeding activities (mid-April to mid-May in Region 2) on mornings with no precipitation and wind speeds less than 16 km per hour.

Attempting to count leks from an aircraft is not recommended. Sharp-tailed grouse are difficult to detect from the air, and their response to an approaching aircraft will vary. They may crouch and become inconspicuous on the lek. Others may flush or retreat to taller cover. The most efficient way to count leks is from a vehicle. This is not always possible for counting CSTG leks in Region 2 because there are frequently no roads within clear sight of the lek, or the roads are impassable due to mud or snow. Obtaining an accurate count is compounded by the fact that the birds are often obscured by vegetation or the lek is on a knoll or ridge where it is difficult to find a vantage point to view the entire lek. For many leks in Region 2, a flush count is the only way to obtain an accurate count. Flush counts are an acceptable method for counting leks as males generally return to the lek within 10 to 15 minutes after being flushed. Males can be counted as they fly back to the lek, but more often, some males return by flying while others walk. Birds that walk back can easily go undetected. If females are present on the lek, they usually will not return once flushed. However, other females may visit the lek after the males return.

If the observer has a clear view of the lek, females can be counted separately from males based on their behavior. Once the birds are flushed, it is not possible to identify males from females. Females move freely through the lek and tend to congregate in small groups near the center of the lek. Females do not perform any type of obvious displays when they are on the lek and exhibit little or no aggressive behavior towards each other or males. Males are distributed across the lek, seldom venture off their territories, and vigorously display and call in the presence of females. Aggressive interactions between neighboring males are common. Males not in the immediate presence of a female will perform flutter jumps in an effort to attract the female's attention. Without having a full view of the lek, an experienced observer can still ascertain if females are present by noting the behavior of the males. The observer can consider this information when needing to conduct a flush count. When the lek is approached, females will usually be the first to flush. The males will generally hold longer and flush as a group. A few stragglers may remain on the lek until the observer gets closer and then flush. If an observer notes little or no activity on the lek prior to conducting a flush count, it is reasonable to assume no females are present.

Lek surveys: Lek surveys are used to find newly-formed leks and previously unidentified leks and to learn if leks have moved to a new location. Lek surveys are usually conducted in conjunction with or secondary to lek counts. Since the primary goal of lek surveys is to find leks, they can be conducted anytime that males are attending leks. The best time to conduct lek surveys is during the peak of breeding activities when males are most active and easiest to detect. Lek surveys can be conducted on foot, by horseback, and from motorized or non-motorized ground vehicles (e.g., mountain bike, trail bike, truck, ATV). Lek searches from aircraft are only practical when snow covers most or all of the ground. Even then, small leks and leks in tall vegetation can be easily missed.

Lek searches conducted only from roads may not be as effective as surveys conducted both on and off roads. Unless roads traverse along ridge tops or across other high points, it may be difficult to hear or see birds on leks. Smaller leks (<12 males) are more difficult to find than larger leks. The standard approach for conducting lek surveys is to walk or drive through suspected or known breeding habitat and to stop approximately every 0.5 km to listen and scan for displaying males. Males may initially stop displaying and calling at the approach of a vehicle. Therefore, the observer should turn off the engine, step from the vehicle, and listen and scan the surroundings for at least 5 minutes before proceeding to the next stop. On calm mornings, males may be heard calling from up to 1 km away. Similarly, the white under tail coverts of displaying males and males performing flutter jumps can be spotted with binoculars or a spotting scope from distances over 1 km. When scanning the surrounding landscape, the visual search effort should focus along ridge tops, knolls, benches, and broad, flat expanses. Observers should watch for birds flying and note where they land. They could be females flying to a lek or males returning to a lek after being flushed by a predator.

Occasionally, lek sites can be located when birds are not present. An abundance of droppings and feathers (lost during skirmishes between males) typically occur on leks, and distinct paths are evident on the ground where the males stomp their feet while displaying. Patches of bare ground and worn vegetation are apparent across the lek site, especially near the center

where activity is the greatest. Tracks may be imprinted into the bare ground from when the males displayed on wet mornings. It is possible to locate the actual lek site by searching areas suspected of supporting a lek for evidence of these features.

Dropping counts: Dropping counts are used to ascertain presence of grouse in an area. The basic sampling approach is to establish random transects of a specific length. Plot frames of a fixed size and shape (circle or rectangle) are placed on the ground at pre-selected intervals along each transect and searched for droppings. The number of droppings within each plot and total number of droppings along each transect are recorded. These measurements provide an indication of the intensity of use of the area sampled. No reliable method has been developed to relate number of droppings counted to number of birds that produced those droppings. Thus, measurements cannot be used to make inferences about the density of grouse using the area. Investigators conducting dropping counts in Region 2 must be aware of the presence of other grouse species and have the ability to identify their droppings from those of CSTG.

Strip (transect) census: Data obtained from a strip census are used to calculate an index of density. A strip census is conducted by walking a series of transects of fixed length and width and recording the number of birds flushed. Using a trained hunting dog increases the efficiency in finding and flushing grouse. Another approach is to use several observers and have them drag a rope or light chain between them. The strip census provides an estimate of the density of grouse per unit of area searched. To obtain a valid density estimate, transects must be randomly located and sample all known cover types that may be used by CSTG in the area being searched. Strip census also can be used to obtain density estimates within a specific cover type. For instance, transects can be randomly located but limited only to CRP lands within the search area. Transects must be located in a manner that minimizes the chances that grouse flushed and counted on one transect fly to another transect where they are later flushed and counted again.

Brood surveys: Brood surveys are conducted by driving established routes through known brood-rearing and summering areas during early morning (sunrise to 0900 hrs) and evening (1800 hrs to sunset) and recording the number of broods observed, number of chicks observed per brood, and number of other (i.e., males or females unaccompanied by chicks) birds observed. This information can be converted into birds observed per km, broods observed per km, average brood size, and chicks observed per adult. Data obtained on brood routes for CSTG cannot be used to estimate the ratio of successful to unsuccessful females due to the similarities between males and females. Unless an adult grouse observed on the route is accompanied by chicks, it is not possible to ascertain if the bird is a male or female.

Brood surveys are conducted in early August when chicks are sufficiently large enough to fly but small enough so they can be distinguished from adults. The routes should be completed within a 2-week period or less. Extended sampling periods may create bias due to changes in behavior and distribution of birds. The observer first attempts to count the birds from the vehicle and then exits the vehicle and walks through the area to count birds as they flush. Some chicks will hide and hold tight rather than fly. Use of a trained hunting dog will increase the observer's ability to locate chicks. Collins (2004) found that use of a trained hunting dog after completion of a traditional flush count without the dog resulted in 16 percent more chicks being flushed.

Routes should not exceed 35 km in length and should be driven at about 20 km per hour. This will allow sufficient time to flush and count any birds observed and still complete the survey in less than three hours. Due to their length, brood routes must be conducted from a motorized vehicle. Only one person is needed for each route. Attempts to conduct brood routes for CSTG have had limited success. Rogers (1969) reported finding only one CSTG brood along 521 km of brood routes surveyed in Colorado during the first two weeks of August. Rogers (1969) attributed his lack of success to the scattered distribution and low densities of CSTG in Colorado during the early 1960's when he conducted his investigation.

Detection rate also may have had a part in Rogers (1969) lack of success in finding broods. The wary nature and secretive habits of CSTG broods along with the dense cover used for brood-rearing habitat are factors that contribute to their low detection rate. The types of roads over which the surveys are conducted also can be important. Columbian sharp-tailed grouse likely avoid well-traveled roads and roads bordered by fences or utility lines that offer perching sites for avian predators. Shorter routes that can be intensively searched on foot with dogs may be a better approach to conducting brood surveys than surveys conducted from vehicles along established roads. Even this approach may not produce sufficient observations. Over two summers of searching for broods with a dog from early June to late August,

Klott (1987) only flushed 44 CSTG broods, of which 16 flushes were of previously observed broods (total individual broods encountered = 28).

Winter counts: Winter surveys are conducted primarily to identify wintering areas and secondarily to count the number of birds using these areas. No standardized method has been developed for assessing winter populations. In states where winter habitat is limiting and readily accessible, conducting winter counts may have some merit in assessing populations, especially when snow cover prevents the birds from feeding on the ground and causes them to use riparian corridors where they feed in shrubs above the ground. Under these conditions, birds are more conspicuous and relatively easy to observe and count.

Winter surveys are probably not a viable option for assessing CSTG populations in Region 2 for several reasons. Columbian sharp-tailed grouse can be extremely difficult to locate in winter in Region 2, as winter habitat does not appear to be limiting (Hoffman 2001). Further, studies in Region 2 suggest that the birds are distributed over large areas during winter (Collins 2004, Boisvert et al. 2005). Perhaps the main obstacle to conducting winter surveys in Region 2 is access. Columbian sharp-tailed grouse in Region 2 primarily winter above 2,100 m elevation where snow cover commonly exceeds 100 cm from December through March. Access even by snow machine can be difficult due to lack of packed trails and steepness of the terrain. The value for conducting winter surveys in Region 2 would be to gather information on the location of important wintering areas.

Lek routes: Lek routes are a form of lek count with the distinction that a lek route is an attempt to count a group of leks in one morning that are relatively close together and are believed to represent part or all of a single breeding complex. Lek routes are most practical in areas with a network of accessible rural roads that allow the observer to cover long distances within a single morning. Applegate (2000) observed that roads are not randomly distributed and lekking grouse may avoid certain types of roads. This could lead to biases in interpretation of the data obtained from lek routes.

Lek routes are used to survey known leks, to locate new leks that become established along the route, and to ascertain if known leks have changed locations. On lek routes, an observer ascertains the presence of active lek sites by driving along a standardized route and stopping the vehicle (turn off the engine) and listening at periodic intervals for the vocal sounds of displaying males. Routes are usually 16 to 32 km long, with listening points at 0.5 to 1 km intervals. The same route is run every year. The direction and approximate distance to all audible leks are recorded. All leks detected along the survey route are visited (preferably the next morning), and the number of birds present is recorded. In addition, all lek sites known to be active in previous years, but not detected during the survey, are visited to learn if they are still active or if the lek site has moved to a new location. If another lek is located within 0.5 km of an inactive site, it should not be classified as a new lek.

Wing surveys: Collection and analysis of wings obtained from hunter-harvested birds can be used to assess reproductive performance in grouse populations (Hoffman 1985, Giesen 1999). Wings are collected at hunter check stations or operation of volunteer wing collection stations placed at strategic access points to popular hunting areas (Hoffman 1981). The validity of using information obtained from wing samples to draw conclusions about the population is based on the assumption that different age and gender classes are harvested in proportion to their occurrence in the population. This assumption has not been tested for CSTG. Unwary juveniles may be more vulnerable to harvest than adults are or males may be more vulnerable than females due to their tendency to return to leks in the fall.

A major challenge of wing collections, particularly for lightly hunted populations, is obtaining an adequate sample of wings. Giesen (1999) reported data on CSTG populations based on wing samples collected over a 22-year period from 1976 to 1997. Samples exceeded 100 wings in only eight of 22 years. Another limitation of wing collections with regards to CSTG is that no reliable technique has been developed to distinguish females from males based on wing characteristics. Despite these limitations, two potentially useful indices of productivity that can be derived from the analysis of CSTG wing samples are percent juveniles in the harvest and the ratio of juveniles to adults (includes yearlings). Wing data should not be used to make inferences about population trends. The data are best used to complement information collected using other survey methods.

Lek densities: Cannon and Knopf (1981) suggested that lek density, instead of the number of males on leks, could be used to derive a lek index that reflected population changes. They found that the number of leks of lesser prairie-chickens exhibited a strong positive correlation with density of displaying males. In comparison, average lek size was highly

variable at high population densities. The increased variability in average lek size was attributed to formation of numerous, small, temporary leks at high population densities. When these small, temporary leks are factored into the computations, average lek size may not change or could possibly decrease.

The problem with this approach as addressed by Schroeder and Braun (1992) is that lek densities can be difficult to estimate and seldom are obtained with a corresponding estimate of precision. Part of the problem is that leks are not equally detectable due to their size and topographic position on the landscape. Measurement of lek densities for CSTG would be extremely labor intensive, except on small areas. To search large areas to derive a regional estimate of lek densities would require use of aircraft. For reasons already discussed, CSTG leks cannot be accurately located from the air. Thus, large areas would need to be intensively searched on the ground. Even if this was possible, numerous other factors including weather during the survey, timing of the survey, disturbance by predators, and observer bias may influence the ability to detect leks.

Lek counts revisited: Of the survey methods discussed, lek counts appear to offer the best opportunity for monitoring CSTG populations. Leks are relatively easy to locate, observe, and count, which is why lek counts have become an integral part of prairie grouse management programs. However, lek counts are not without problems. Investigators have questioned the validity of using lek counts as a tool for estimating population trends because of known variations in lek attendance patterns among male prairie grouse (Beck and Braun 1980, Robel 1980, Applegate 2000, Anderson 2001, Walsh et al. 2004). These investigators did not advocate that lek counts be discontinued. Instead, they recommended that studies be conducted to better understand the problems associated with lek counts and possibly to develop correction factors to derive a more rigorous index to population change using lek counts.

Walsh et al. (2004) recommended that lek counts can be improved upon by minimizing sources of variation through standardization of counting protocols and by using trained observers to conduct the counts. They prefaced their recommendations by noting that until lek counts are calibrated to population parameters by estimating detection probability, managers must realize the limitations of lek count data. Walsh et al. (2004) further noted that estimating the number of unknown leks is another essential component of allowing lek counts to be properly related to population size and trends.

Walsh et al. (2004) proposed the use of a modified sightability model as an option for correcting lek count data and for estimating population size of greater sage-grouse on known leks. The correction technique requires a specific set of design criteria to obtain the required data. The technique can only be applied to a geographically closed population, individual birds must be radio-marked prior to lekking season, observers must monitor the marked birds daily throughout the lekking season, and counts of all known leks must be conducted concurrently with the monitoring of marked birds.

The size (>250 known leks) and distribution (>7,800 km^2) of the CSTG population in Region 2 preclude any possibility of developing a sightability index model for correcting lek counts. No effective technique has been developed for capturing CSTG outside the lekking season. Techniques used to capture other grouse during periods when they are not attending leks, such as baiting or night-lighting during winter, have proven unsuccessful in capturing CSTG. Until a technique is developed, it will not be possible to conduct an unbiased assessment of CSTG lek attendance patterns, estimate the number of unknown leks, or develop a sightability index model for correcting lek counts. However, if a way is found to capture CSTG other than during the lekking season, it may be feasible to develop sightability models for estimating population size of CSTG in smaller areas where they have been recently transplanted in Region 2.

Inventory and monitoring habitats

Habitat characterization for CSTG should follow the processes described by Johnson (1980) as recommended by Connelly et al. (2003) for greater sage-grouse and Robb and Schroeder (2005) for greater prairie-chickens. Johnson (1980) described habitat selection as a hierarchical process and used different levels of selection to illustrate this process. First-order selection represents habitat characteristics within the geographic range, second-order selection represents habitat characteristics of the home range, third-order selection represents use of different habitat components within the home range, and fourth-order selection represents habitat characteristics of particular use sites (i.e., feeding, loafing, escape, nesting, and brood-rearing). The orders range from macro- to micro-scale components for habitat selection. Analysis of habitat use at both scales is important for understanding animal-habitat relationships. For CSTG in Region 2, studies have focused on macro- (first and second order selection) and micro-scale (third and fourth order selection) habitat components of seasonal

use areas, but macro-scale components are probably more clearly described and understood than micro-scale components.

At the regional scale, habitat data can be collected from maps, aerial photographs, and satellite imagery. Data obtained from these sources seldom reveal any information about condition of the habitat. In addition, since it may be difficult to distinguish among some land-cover classes, caution must be exercised in interpreting the data. For example, cover types of known importance to CSTG, such as CRP and mine reclamation, may not be distinguishable from cover types of less importance, such as pasture, hayfields, and certain crops. Collecting data from maps, aerial photos, and satellite imagery is often a necessary starting point for identifying the distribution of cover types important to CSTG. Aerial photographs and satellite imagery can be used to refine this information by discerning the extent of fragmentation across the landscape and by revealing changes in the landscape over time. Aerial photographs and satellite imagery in combination with Geographic Information System technology also can be used to ascertain size and configuration of habitat patches, juxtaposition of habitat patches, and distance between habitat patches. Use of photos and imagery taken over time is an extremely valuable tool that managers can use to inform decision makers and the general public about the impacts of land use changes on wildlife populations. An example where this approach would be useful in Region 2 is monitoring the expansion of oil and gas development within the occupied range of CSTG.

The next level of habitat monitoring is to measure features of the habitat at the local scale, where CSTG occur. Emphasis at this level should be placed on measuring habitat variables of biological importance to CSTG (**Table 18**). An unbiased characterization of the habitat is necessary for these data to be meaningful. This involves measuring habitat attributes at CSTG use sites as well as at random sites using the same techniques. Stratification by land use (grazed or ungrazed), cover type (native or non-native), or density (high, medium, low) of grouse will provide more meaningful information.

Applicable methods for measuring micro-habitat characteristics of cover types used by CSTG are line intercept (Canfield 1941), Daubenmire plots (Daubenmire 1959), and cover poles (Robel et al. 1970, Griffith and Youtie 1988, Benkobi et al. 2000) or variations thereof. Each method is best suited for measuring different habitat characteristics. The line intercept method is most commonly used to measure shrub cover, Daubenmire plots have advantages for measuring herbaceous cover, and cover poles are used to measure vertical cover. The most complete and useful information is obtained when all three methods are used to quantify habitat characteristics. Regardless of the method used, cover values should be recorded by species rather than by categories of species (i.e., grasses, forbs, and shrubs) because some species are of greater value to CSTG than others are. The information can be combined later, if upon further analysis, species composition is not of interest.

Table 18. Habitat variables of potential importance to Columbian sharp-tailed grouse.

Habitat variable	Seasons of primary importance
Distance to mountain shrub and shrubsteppe cover	Winter, spring, fall
Height and density of shrubs	Winter, spring, fall
Shrub patch size and configuration	Winter, spring, fall
Percent forb cover	Spring and summer
Height and density of grasses	Spring and summer
Percent grass cover	Spring and summer
Species richness	Spring and summer
Visual obstruction	Spring and summer
Percent bare ground	Spring and summer
Distance to nearest other cover type	Spring and summer
Percent residual cover	Spring
Snow depth and texture	Winter
Aspect	Winter
Slope	All seasons
Species composition	All seasons

Boisvert (2002) and Collins (2004) measured habitat variables at CSTG use and random sites along transects radiating from the plot center in the four cardinal directions. Line intercept, modified Daubenmire plots, and cover pole readings were taken along each transect. Boisvert (2002) used 20-m transects and Collins (2004) used 10-m transects. Giesen (1997) used cover board (Jones 1968) and point center-quarter (Cottam and Curtis 1956) methods to quantify habitat characteristics at CSTG use and random sites. Oedekoven (1985) conducted vegetation sampling along 100 m transects. Techniques used to measure vegetation included line intercept, point center-quarter using the nearest shrub, quadrat sampling, and a 10-pin point frame. Klott (1987) measured vegetation at brood and random locations along two 20-m intersecting transects with the intercept placed on the flush point of the brood or random point. Shrub cover was measured by recording the shrub species present at 40-cm intervals along each 20-m transect. Cover of herbaceous species was ascertained using Daubenmire plots, and a cover board was used to estimate horizontal screening effects of the vegetation. The multitude of approaches used in these studies conducted in Region 2 indicates that standardized techniques for measuring micro-scale characteristics of habitats used by CSTG are not well established. Standardized and proven techniques are necessary to provide rigorous and consistent data sets to allow for comparisons among areas and years.

Management approaches

Managers must be acutely aware that CSTG populations are affected by multiple factors and that the cumulative effects of these factors must be considered in formulating future management actions. The public's knowledge of this situation should be enhanced. The public needs to be informed about the importance of sagebrush and mountain shrub ecosystems and the threats human activities pose to these ecosystems and their associated wildlife. Most importantly, the public's misconception that sagebrush communities are wastelands of little or no value must be corrected. A concerted educational effort should be directed towards those sectors of the public whose land use practices and activities directly threaten CSTG populations and their habitats. Every effort must be made to involve them in development of management strategies to address threats that their practices and activities have on CSTG. State wildlife agencies should seek help from conservation organizations, such as the North American Grouse Partnership, Audubon Society, National Wildlife Federation, and The Nature Conservancy, in developing, implementing, and delivering public educational programs to protect CSTG populations and their habitats.

Seasonally, CSTG restrict their activities to relatively small areas, but on an annual basis, the area occupied may be extremely large and involve a mix of ownership and jurisdictions. Thus, successful management will require transcending political and jurisdictional boundaries and must involve cooperation among the different state and federal resource management agencies and between these agencies and private landowners. Management approaches may differ locally and regionally depending on the professional judgment of biologists and the availability of quantitative data from population and habitat monitoring. Whatever strategies are selected, it is imperative that agencies use an adaptive management approach to evaluate the success of implementation (Macnab 1983).

Ironically, some of the same activities responsible for loss and degradation of shrubsteppe and mountain shrub habitats also may be used to enhance and restore these habitats. These activities include fire, grazing, herbicides, and mechanical treatments. Decisions on land treatments using these tools should be based on quantitative knowledge of vegetation conditions over an entire population's seasonal range (i.e., breeding, nesting, brood-rearing, and winter ranges). The treatment selected should be the one that is least disruptive to the vegetation community and has the most rapid recovery time, particularly if the area to be treated is being used by grouse. Selection should not be based solely on economic cost. Treatments should not be undertaken until the limiting vegetation factor(s) has been identified, the treatment is known to provide the desired vegetation response, and land-use activities can be managed after treatment to prevent damage to the treated area.

Giesen and Connelly (1993) described the primary habitat requirements of CSTG and presented guidelines for the management of CSTG populations and their habitats. They acknowledged that because of the lack of experimental data on the effects of habitat alterations on CSTG populations, their recommended guidelines represent hypotheses to be tested and that new information could result in the guidelines being modified. Their specific guidelines include:

- monitor and maintain records of the location of CSTG lek sites

- delete from the records any leks that have been inactive for five consecutive years

- produce maps of all known lek locations and provide these to land management agencies for use in environmental evaluations of proposed management activities

- avoid vegetation manipulation within the breeding complex (defined as the lek and all land within a 2-km radius)

- if vegetation manipulation must occur within the breeding complex, defer it until grouse population levels are ascertained and a comprehensive management plan has been formulated for the area

- monitor the impacts of vegetation manipulation on lek attendance and nesting success for possible mitigation

- if disturbance (physical, mechanical, or audible) within the breeding complex is unavoidable, it should not occur during the breeding season (March to June)

- avoid manipulation or alteration of vegetation within the breeding complex during the nesting season (May to June)

- implement management practices that will not reduce the height, canopy cover, or density of chokecherry, snowberry, sagebrush, serviceberry, or other shrubs locally important for food and cover

- maintain adequate height-density (mean Robel pole reading = 2.5 dm, Robel et al. 1970) of residual grasses for nesting

- avoid vegetation manipulation or disturbance that results in the loss of deciduous tree and shrub height, canopy cover, and density within 100 m of streams, including intermittent and seasonally dry secondary drainages

- manage or eliminate livestock use of riparian areas to minimize destruction of shrubs and trees

- avoid manipulation or disturbance of vegetation, including herbicide applications, burning, or mechanical destruction that results in long-term (>5 years) or permanent reduction of height, canopy cover, or density of mountain shrub habitats if shrubs comprise less than 10 percent of the total cover within the area of concern

- restrict management practices to rejuvenate or increase mountain shrub communities to 25 percent or less of this cover type annually.

Since Giesen and Connelly (1993) published the CSTG management guidelines, numerous other studies have been conducted. Most of these studies provided their own set of recommendations for managing CSTG populations or their habitats based on the data collected. An attempt is made in this assessment to present recommendations using the most current and accurate information available in an effort to complement and update the guidelines by Giesen and Connelly (1993). These recommendations are intended as a guide for resource managers and decision makers to consider when formulating management strategies to address the primary threats identified in this assessment. Actions taken to protect, enhance, or restore particular sites will depend on the characteristics of the particular site and the surrounding landscape. Managers will need to adapt the recommendations presented in this assessment to their particular situation. Managers are encouraged to review the Northwest Colorado Columbian Sharp-tailed Grouse Conservation Plan (Hoffman 2001). This plan contains 248 conservation actions designed to address 23 issues that may affect CSTG in Region 2. Managers also should familiarize themselves with plans that have been developed for CSTG in other states and British Columbia when formulating management strategies for Region 2 (Ritcey 1995, Tirhi 1995, Ulliman et al. 1998, Utah Division of Wildlife Resources 2002).

Managers should be aware of the potential effects on other species of actions taken to benefit CSTG. Where CSTG and sage-grouse occur sympatrically, managers should use extreme caution in treating sagebrush to benefit CSTG. Any loss of sagebrush could be detrimental to sage-grouse and other sagebrush-obligate species, particularly where sagebrush has already been severely depleted or degraded. Managers are encouraged to consult the literature for information on managing sagebrush habitats for species such as greater sage-grouse, Gunnison sage-grouse, sage sparrows (*Amphispiza belli*), sage thrashers (*Oreoscoptes montanus*), and Brewer's sparrow (*Spizella breweri*) before proceeding

with sagebrush treatments to benefit CSTG. Columbian sharp-tailed grouse are not truly a sagebrush obligate, but shrubsteppe communities dominated by sagebrush provide critical breeding, nesting, and brood-rearing habitats for CSTG. Therefore, habitat management strategies for sagebrush-obligate species should benefit or not harm CSTG.

Finally, managers should be aware that far too much emphasis is placed on developing management strategies to protect lek sites without consideration for other seasonal habitat needs. The lek site is only as important as the quality of the surrounding habitat. The consequences to CSTG of having to shift a lek location are probably far less than having to find new areas to nest and raise their broods.

Restoration: Successful management and conservation of CSTG in Region 2 will depend upon preservation and maintenance of healthy sagebrush and mountain shrub communities and implementation of programs to enhance and restore degraded areas. Where possible, restoration efforts should attempt to approximate naturally occurring landscapes. On some areas, restoration may simply require resting the landscape and allowing it to recover naturally. On other areas, the landscape may be so seriously degraded or altered that important plant species are totally absent and a natural seed source is no longer present. Under these conditions, restoration becomes much more difficult and complicated. Natural recovery is neither feasible nor ecologically practical in this situation. For some species, there is no way to rectify their loss because a commercial seed source is not available and procedures for establishment are unknown. If severe degradation has occurred and natural recovery is unlikely, managers must develop restoration programs with the goal of establishing the most ecologically stable community that can exist on the site to protect the soils, maintain the desirable native species that remain, and prevent further degradation. Use of introduced species should not be excluded, but their inclusion requires a greater understanding of their growth form, persistence, effect on native species, and value as food or cover for wildlife. Many severely degraded areas can be substantially improved with proper site preparation, seed selection, and seeding practices, and returned to a condition where they provide suitable habitat for CSTG.

Restoration programs must include strategies for controlling and preventing noxious weeds. Concessions must be made in eliminating or modifying land management practices that contributed to the degradation of the site. Similarly, future uses of the site must be considered and agreed upon before implementing a restoration program. The objectives of the program need to be clearly defined and attainable. Remedial treatments, including management of sites to promote natural recovery, must be carefully planned and directed. Monsen (2005) prepared a comprehensive manual for the restoration of sagebrush and associated shrubland communities. This manual contains information directly applicable to restoration of shrubland communities in Region 2 and should be mandatory reading for all wildlife and land managers within the historic and occupied range of CSTG in Region 2. The manual was specifically prepared to address recovery of sage-grouse habitats, but has direct application to management and restoration of CSTG habitats in Region 2.

Active restoration involves the physical removal of competitive species, preparation of seed beds, and seeding of desired species. A number of species are usually planted, and it is essential to understand the requirements for successful establishment for each species included in the seed mixture (Monsen 2005). Seeds of some species may need to be broadcast while seeds of other species may need to be drilled into the soil at various depths. Lack of attention to all aspects of site preparation and seeding practices could result in widespread failures.

Seeds of many native species were not universally available in the past and little was known about how to plant the seed, and the high cost of native seeds that were available prohibited their use in large restoration projects. This situation has changed in recent years. Private companies and several states have developed their own native seed programs. These efforts have increased the availability and lowered the cost of native seed. In addition, substantial information has been published on seed germination requirements, seedbed preparation, and planting practices for many native species (Monsen 2005).

Administrators of federal and state wildlife and land management agencies should be encouraged to support and fund native seed programs and to develop programs where they do not currently exist. These programs could have positive economic benefits to rural communities. For example, private landowners could be contracted to grow and harvest the seed of locally-adapted plants needed for restoration of native habitats.

Fire: Historically, fire was integral to maintaining CSTG habitats in Region 2. In the absence of natural fires, prescribed fires can be used as a management tool to maintain, enhance, and restore CSTG habitats. Because plant communities respond differently to fire, managers must adhere to burning techniques applicable for the conditions and vegetation types involved (Whisenant 2004). Burn prescriptions for CSTG will differ among grassland, sagebrush, and mountain shrub types. Prescribed fire is the preferred method for treating CSTG habitats because it most closely mimics natural disturbance. However, managers tend to encounter more obstacles to using fire than other methods of treatment. Obtaining burning permits can be difficult where air quality is of concern. Fire cannot be used in many areas because of the potential threat to human life and property. The cost of conducting a prescribed fire has greatly increased due to the liability issues if the fire gets out of control and burns non-target areas. Finally, the public generally has a negative view of fire and does not understand its positive values. This makes it more difficult for managers to promote prescribed fire to their superiors.

Fire is particularly useful in habitats occupied by CSTG for reducing density and competition within mature and over-mature plant communities. Most perennial grasses and forbs within the native cover types occupied by CSTG are moderately resistant to burns. Thus, stands of dense big sagebrush or mountain shrub can be burned to improve the yields and density of grasses and forbs in the understory. Composition, density, and distribution of grasses and forbs must be adequate to achieve the desired response to burning. It is recommended that an inventory be taken of the understory species present within the stand prior to burning. If ground cover is less than 10 percent for grasses and 10 percent for forbs, and only half the expected species of grasses and forbs are present, reseeding should be considered following the burn to promote recovery of the herbaceous community. If annual weeds comprise greater than 10 percent of the ground cover, burning is not advisable as it may accentuate the weed problem. Chemical treatment may be necessary to control weeds followed by burning and reseeding with desirable grasses and forbs.

Shrubs vary in their ability to recover or resprout after fire. The time required for shrubs to re-establish is an important factor to consider when using fire as a management tool. Sagebrush communities recover slowly and have a greater chance of being negatively impacted by fires than mountain shrub communities. The distribution and health of sagebrush-dominated communities within the occupied range of CSTG in Region 2 are less than optimal. Any treatment of the remaining sagebrush must be carefully planned and approached with caution to not cause any further loss or degradation of this important cover type. The primary types of sagebrush within the occupied range of CSTG in Region 2 are mountain big sagebrush (*Artemisia tridentata vaseyana*), Wyoming big sagebrush (*A. t. wyomingensis*), basin big sagebrush (*A. t. tridentata*), and to a lesser extent, silver sagebrush (*A. cana*). With the exception of silver sagebrush, all must recover from fire through seedling establishment (Winward 2004, Monsen 2005). Viable seeds must be incorporated into the soil seed bank and climatic conditions must be highly favorable to insure seedling establishment and development (Winward 2004, Monsen 2005). Depending on the type of sagebrush and size and intensity of the fire, re-establishment may take 20 to 30 years.

Better moisture conditions and greater annual seed production make mountain and basin big sagebrush sites more suited for burning than Wyoming big sagebrush sites (Monsen 2005). However, even on mountain and basin big sagebrush sites, recovery can be unpredictable (Monsen 2005). A conservative plan is the safest and recommended approach to using fire or any other type of treatment (i.e., chemical or mechanical) as a management tool in sagebrush communities. No more than 20 percent of the area should be burned. Several small burns varying in size from 2 to 10 ha in a patchwork pattern is recommended over a single, large burn. Every effort should be made to contain the burn to the area in need of treatment. Not all over-mature or dense (>40 percent canopy cover) stands of sagebrush should be targeted for treatment. Some of these stands should be retained on the landscape as they may provide escape cover for CSTG grouse, especially if the stands occur near (≤ 400 m) lek sites.

Burning should not occur during or following years of drought or during the nesting and brood-rearing seasons. Early spring (early to mid-April) or late fall (late October to late November) burns will produce the best results with the least immediate impacts. Besides disrupting nesting and brood-rearing, late spring, summer, and early fall burns have the potential to destroy seed-bearing plants and leave little seed in the soil seed bank. If summer or fall burning is the only option, seed bed preparation and reseeding should occur following the burn. Any reseeding should be done in the fall. Where possible, pockets of live sagebrush plants and native grasses and forbs should be maintained as a seed source within the perimeter of the

burn. Burns on broad ridgelines, mesas, benches, and flats will benefit CSTG more than burns along narrow drainages or on steep (>20 percent) slopes. Additional treatments should be deferred until the initially treated area again provides suitable habitat for CSTG. Treated areas should be rested from grazing for at least three years and preferably five years to allow for seedling establishment and development. Subsequent grazing should be light to moderate.

Burning to eradicate sagebrush or mountain shrub communities to improve grass production for livestock should be discouraged. Range fires that threaten to destroy large (>100 ha) areas of sagebrush should be suppressed because of the long time period required for sagebrush to become reestablished and the uncertainty that it will re-establish. The possible exception is when wildfires start where extensive conifer invasion has occurred within the sagebrush type. Seeding with the appropriate subspecies of sagebrush is recommended during the first fall following the fire to promote re-establishment of sagebrush.

Mountain shrub communities are more resilient to burning than sagebrush. The most prevalent and dominant shrub species within the mountain shrub community in Region 2 are Gambel's oak and serviceberry. These species may grow in association with chokecherry, mountain snowberry, and big sagebrush, or they may form separate, dense thickets to the exclusion of the other species. With the exception of big sagebrush, most shrub species in the mountain shrub community are fire tolerant and resprout after fire (Monsen 2005). This allows for shorter recovery time and precludes the need for reseeding or dependence on a natural seed source for re-establishment.

Burning should only occur in over-mature or dense mountain shrub stands that are considered unsuitable for CSTG. Due to the shorter recovery time, larger burns (20 to 100 ha) are acceptable within the mountain shrub type. No more than 30 percent of the stand should be burned at one time. Subsequent burns can be conducted at five to 10 year intervals as needed. Where mountain shrub communities comprise less than 15 percent of the landscape, a more conservative approach to burning is recommended. Individual burns should be smaller (2 to 10 ha), burn intervals should be longer (10 to 15 years), and no more than 10 percent of the area should be burned at one time.

Where fire has been absent or suppressed for long periods within the mountain shrub type, large contiguous patches of Gambel's oak dominate the landscape. Columbian sharp-tailed grouse avoid these areas, except where the patches border more open cover types. Repeated burning of oakbrush stands at approximately five to 10-year intervals can improve their value as habitat for CSTG by reducing the prevalence of oakbrush and allowing other shrub species (i.e., serviceberry and chokecherry) of greater importance to CSTG to become established. Repeated burning also can be used to create and maintain herbaceous openings within the mountain shrub community that may provide late summer and fall habitats for CSTG and snow roosting sites in winter. Stands dominated by desirable species, including serviceberry and chokecherry, also may become too dense and over-mature and require burning to improve their suitability for CSTG.

The greater resiliency of mountain shrub species to fire provides managers with more options for dealing with wildfires. Managers should consider adopting a "let burn" policy for wildfires within the mountain shrub zone where there is no threat to human life or property, mountain shrub communities comprise greater than 25 percent of the landscape, and the area where the fire has started is in need of disturbance (i.e., the stands are too dense, over-mature, or dominated by oakbrush). Fire management plans prepared by the BLM, USFS, and counties should be reviewed, and where appropriate, advice should be provided on ways to modify the plans to benefit CSTG.

Chemical and mechanical treatments: Chemical and mechanical treatments can be used to manipulate shrub density when prescribed fire is not feasible or where the treatment must be precisely applied to prevent damage to adjacent areas. Mechanical and chemical treatments each have their advantages and disadvantages (Stevens and Monsen 2004, Vallentine 2004, Monsen 2005). The primary drawback of chemical treatments is their effect on non-target, desirable plant species, particularly forbs, but also shrubs. Another negative effect is the reduction in insect populations that use forbs and shrubs that are killed by the herbicide. For these reasons, widespread aerial or ground application of herbicides that also harm non-target forbs and shrubs is discouraged, except when such treatments are necessary to control invasive plant species. Whenever possible, herbicides should be applied with ground equipment so that only areas supporting invasive species are treated. This will minimize the damage to non-target species. Non-specific herbicides should only be used on localized areas where their application can be carefully controlled.

There are herbicides on the market that target specific plant species (Vallentine 2004). These herbicides applied at low rates can be used to selectively control but not totally eliminate target plants in an area. One herbicide that has been used to thin big sagebrush stands and simultaneously stimulate grass and forb production is tebuthiuron (Crawford et al. 2004). Tebuthiuron and other similar-acting herbicides offer obvious advantages over broad-acting, non-specific herbicides. Their use as a tool for managing CSTG habitats should be considered.

Applications of restricted use pesticides must follow the "directions for use" section on the product label, and the applicator must be certified by the state. It is a violation of federal law to apply restricted use pesticides in a manner that is inconsistent with the labeling. Vallentine (2004) and Monsen (2005) provide a complete discussion of the different types of equipment that can be used for chemical control of plants. First and foremost, the method of application should be based on safety and precision of application. Herbicides undergo extensive toxicological, environmental, and plant efficacy testing. Applicators should consult this database of knowledge to select the safest herbicides to use for each weed and brush control program.

Many types and variations of mechanical treatments can be used to remove undesirable trees, shrubs, and weeds and to prepare the soil for natural revegetation or for reseeding, including chains, plows, harrows, choppers, mowers, shredders, aerators, and disks (Stevens and Monsen 2004, Monsen 2005). Mechanical treatments may damage or kill non-target plants, but depending on the type of mechanical treatment, the effects on non-target plants are usually less than may occur from fire and non-specific chemical treatments. Mechanical treatments are easier to control the size and shape of the treatment, amount of brush removed, and timing of the treatment. Mechanical treatments are less effective in controlling sprouting shrubs, may increase the risk of erosion, tend to have a shorter treatment life than fire or chemical treatments, and may have limited use on steep, rocky, or inaccessible terrain.

McArdle (1977) found that CSTG in the Curlew Valley of Idaho responded favorably to chaining, burning, and spraying, but chaining appeared to provide the most benefit. Chaining had more of an immediate, positive effect on the overall cover. This resulted in CSTG increasing use of the chained areas more rapidly than in areas that were sprayed or burned. McArdle (1977) recommended that manipulations should be done in an irregular pattern with not less than 30 and no more than 45 m between the sides of the pattern to maximize the "edge effect" of the treatment.

Grazing: No single grazing strategy is appropriate for all grassland or shrubland habitats occupied by CSTG. Grazing management must be tailored to the condition and potential of each grazing unit (Holechek et al. 2001). This includes recognizing where and under what conditions grazing is not an ecologically appropriate practice. Sound grazing management must include strategies to protect the plant resource and promote ecological stability (Holechek et al. 2001). Public land managers and livestock producers should use the relative abundance of key wildlife species as an indicator of range condition. If species such as sage-grouse and sharp-tailed grouse are absent or occur in low numbers, this is a strong indication the range is in suboptimal condition. Part of good range stewardship is being aware of and providing for the needs of wildlife. Wildlife professionals and livestock producers must become more tolerant, understanding, and respectful of each other's perspectives and focus on areas of mutual interest.

The ultimate goal should be to provide for a level of grazing that at least maintains and ideally improves the long-term stability of CSTG populations and their habitats in Region 2. This is a realistic goal considering there are already areas in Region 2 where healthy grouse populations occur on lands that are grazed by domestic and wild ungulates. Ironically, some of the most abused and overgrazed ranges within Region 2 occur on public lands administered by the USFS, BLM, and State Land Board. This is partially due to past grazing management practices, but it is compounded by current grazing patterns. Stocking rates have declined considerably on public lands, but agencies responsible for their management have not rested the lands and allowed them to recover from past over-use. Without rest, there has been no opportunity for recovery. This explains in part why public lands account for about 32 percent of the occupied range of CSTG in Region 2 but support less than 15 percent of the known active leks.

Public land managers must set the example on how to manage rangelands properly for long-term ecological stability. The following guidelines for managing livestock grazing on public lands are adapted and modified from The Wildlife Society's final position statement on livestock grazing on federal rangelands in the western United States (www.http://wildlife.org, accessed 5 November 2006). Many of the guidelines are applicable to private lands and should be encouraged by

county extension agents and other government officials that work directly with the private sector. Livestock grazing on public lands should:

1. reflect the standard upon which other lands are managed and clearly demonstrate how wildlife and livestock management are compatible

2. be based on rigorous scientific studies

3. consider all rangeland resources, trends, interactions, and human values

4. provide for adaptive management as new knowledge and understanding of rangeland ecosystems becomes available

5. include provisions, funding, and criteria for monitoring

6. allow for flexibility and adaptability to changing habitat and environmental conditions, such as drought

7. involve effective coordination and cooperation among agencies and affected publics

8. allocate ample resources to enforce regulations and to levy strong penalties when regulations are violated

9. promote heterogeneous landscapes comprised of diverse mosaics of plant communities

10. meet conservation objective for threatened, endangered, and sensitive wildlife and plant species

11. promote use of native species for restoration

12. manipulate vegetation by burning, spraying, or mechanical treatment only when necessary to maintain, improve, or restore the health of the plant community

13. avoid projects designed to manipulate vegetation for the sole purpose of increasing forage production for livestock

14. develop and implement objective and quantifiable criteria for designating lands unsuitable for livestock grazing

15. implement strong public education programs that clearly articulate goals and desired outcomes of livestock management

16. allow for effective citizen participation in developing grazing policy alternatives, implementing policy provisions, and evaluating policy outcomes.

Regardless of the grazing management plan that is decided upon, it should adhere to certain grazing principles that are known to maintain healthy rangelands (Montana Watershed Coordination Council's Grazing Practices Work Group 1999). Most plants are generally healthier when properly used but not overgrazed. However, the effects of grazing cannot be judged by averaging use on all plant species. Some species are more preferred than others are. That some species are lightly grazed or not grazed at all does not compensate for other species being heavily grazed. It is important to identify the key species that will serve as indicators of grazing intensity. Key species are the species that livestock are most likely to use the heaviest and will be the first to show signs of over-use. If key species are not overgrazed, it is reasonably safe to assume the other species will not be either. The same concept applies to range condition within the grazing unit. If parts of the grazing unit are untouched or only lightly grazed, while other sections are continually and heavily grazed, averaging the two extremes will not provide an accurate picture of overall condition. If an uneven distribution of grazing is noted, then animal distribution may need to be improved through herding, salting in unused areas, or developing additional water sources.

No grazing unit should be grazed for more than half the growing season of key species. Timing of grazing must allow for growth and regrowth of the key plant species. Periods of use throughout the growing season should be alternated from year to year. At least once every three to four years, the grazing unit should be rested. Grazed pastures should not be over-used to compensate for rested pastures, nor should rested pastures be over-utilized after they are rested (i.e., a year of rest does not compensate for a year of excessive use). If continual seasonal grazing (an area is grazed at the same time every year due to access problems, short growing season, or both) is the only alternative, the stocking rate should be based on achieving light (<30 percent utilization) use of the key species. Under rest rotational grazing, the rested unit should not be grazed until after (mid-July) the nesting season the following year and then at light intensity. Under deferred rotational grazing, a unit should be grazed only once

within the year at light intensity and should be grazed at a different time the following year. Deciding when it is time to move livestock should not rely on calendar dates. Instead, precipitation, plant growth, and target grazing use level should be used to decide when to move livestock to another grazing unit. Whenever the level of use exceeds 50 percent or the forb component of the plant community falls below 15 percent, then a 2-year rest period is recommended to allow for recovery.

One of the critical factors assuring that grazing does not negatively impact grouse habitats is setting a target level of use for key species that will leave adequate cover and food after the grazing animals are removed. The target level required to leave adequate cover for CSTG will generally be lower than what the key plant species can sustain without prolonged damage. For instance, a key species may be able to sustain 40 percent use without any prolonged damage to the plant, but this level of use may not leave enough cover or food for grouse. Therefore, the compatible level of utilization may be 20 to 30 percent. The compatible level of use may change annually and from one site to the next. Under good growing conditions, the compatible level of use will be greater. In drought years, it will be lower. What really matters is not how much vegetation is removed, but how much vegetation is left.

The problem with utilization measurements is that they are difficult to interpret and compare from one year to the next. Yearly vegetation growth on western ranges fluctuates greatly in response to precipitation. Twenty-five percent use in a wet year will have less impact on remaining cover after the grazing season than 25 percent use during a drought year (i.e., the same level of use can equate to different stubble heights remaining after grazing). Hoffman (2001) reported that additional data besides utilization are needed to monitor grazing effectively to insure that areas meet habitat objectives for CSTG. Holechek et al. (1982) recommended that measuring stubble height rather than use would provide a more meaningful and practical measure of evaluating grazing intensity from the standpoint of wildlife. Unlike use, stubble height is easily measured, easily interpreted, and provides a common reference point for decision making regarding grazing levels.

Ulliman et al. (1998) recommended that residual herbaceous cover height in CSTG habitats should be 20 cm or greater based on Robel Pole visual obstruction readings (Robel et al. 1970) at the end of the grazing season. The Habitat Suitability Index Model developed for CSTG indicates optimum nest/brood habitat occurs where Robel Pole readings exceed 25 cm (Meints et al. 1992). Cover pole readings at nest and brood sites in Colorado averaged 37 and 50 cm, respectively (Boisvert 2002). Equating these values to standard use classes for key western range grasses (Holechek et al. 2001), only light use (≤ 30 percent) by livestock appears to be compatible with CSTG use on most range types.

Restored and rehabilitated sites should not be grazed until at least the end of the second growing season following treatment or seeding (reviewed by Stevens 2004). The minimum period of rest from grazing for treated sites will vary with:

- vegetation type treated
- climatic conditions immediately preceding, during, and following treatment
- shrub, forb, and grass species seeded
- seedbed preparation and seeding techniques used
- severity of competing weedy species.

Seeded species must be given the opportunity to establish substantial root systems, to accumulate carbohydrate reserves, and in the case of some grasses and forbs, to produce a seed crop. Shrubs tend to establish more slowly than forbs and grasses do. When shrubs are included in the seed mixture, five to six years of non-use may be required to provide for maximum establishment and development. When grazing is permitted, it should be lighter than would normally be allowed within a fully mature community. Spring and early summer grazing can be damaging to newly established plants and should be avoided. Temporary electric fences or implementation of special hunting seasons may be necessary to minimize excessive use of treated sites by wild ungulates.

Management of CRP: Several studies have suggested that some CRP fields may provide little or no benefit to CSTG and may in fact contribute to higher predation rates and lower nesting success due to lack of structural and vegetation diversity (Sirotnak et al. 1991, McDonald 1998, Boisvert 2002). Seed mixtures in CRP should include a minimum of four grass, three forb, and one shrub species in the following approximate proportions: 70 to 75 percent grasses, 15 to 20 percent forbs, and 5 to 10 percent shrubs (**Table 19**). Bunchgrasses should be favored over sod-forming grasses, and legumes should be favored over other types of forbs. The recommended shrub species for most CRP

Table 19. Recommended plantings for Conservation Reserve Program lands within the occupied and potential range of Columbian sharp-tailed grouse in USDA Forest Service Rocky Mountain Region.

Category[1] and scientific name	Common name	Status
Primary grasses		
Pascopyrum smithii	Western wheatgrass	Native
Elymus trachycaulus	Slender wheatgrass	Native
Bromus marginatus	Mountain brome	Native
Leymus cinereus	Basin wildrye	Native
Secondary grasses		
Festuca idahoensis	Idaho fescue	Native
Poa secunda	Sandberg bluegrass	Native
P. fendleriana	Muttongrass	Native
Pseudoroegneria spicata	Bluebunch wheatgrass	Native
Achnatherum hymenoides	Indian ricegrass	Native
Primary forbs		
Hedysarum boreale	Utah sweetvetch	Native
Medicago sativa	Alfalfa	Introduced
Vicia americana	American vetch	Native
Sanguisorba minor	Small burnet	Introduced
Secondary forbs		
Balsamorhiza sagittata	Arrowleaf balsamroot	Native
Eriogonum umbellatum	Sulphur-flower buckwheat	Native
Linum perenne	Blue flax	Native
Penstemon strictus	Rocky Mountain penstemon	Native
Symphyotrichum chilensis	Pacific aster	Native
Tragopogon dubius	Yellow salisfy	Introduced
Astragalus cicer	Cicer milkvetch	Introduced
Onobrychis viciaefolia	Sainfoin	Introduced
Crepis acuminata	Tapertip hawksbeard	Native
Primary shrubs		
Artemisia tridentata	Big sagebrush	Native
Secondary shrubs		
Ericameria nauseosa	Rubber rabbitbrush	Native

[1]Primary grasses should comprise approximately 50 percent of the seed mixture, secondary grasses 20 percent, primary forbs 15 percent, secondary forbs 5 percent, primary shrubs 8 percent, and secondary shrubs 2 percent.

plantings within the range of CSTG is big sagebrush. It is important to plant the correct subspecies of big sagebrush based on local conditions (Winward 2004, Monsen 2005).

Appropriate introduced species, such as alfalfa, are acceptable and can be especially valuable where they provide an ecological substitute for structurally important but commercially unavailable native species (Rodgers and Hoffman 2005). Aggressive species that may crowd out other components of the mixture should be avoided, as should weak-stemmed species that flatten easily under heavy snows. Site-adapted seed should be planted over other seed sources when available. This is highly recommended for sagebrush plantings (Monsen 2005).

The potential height of the mature stand should be considered in selecting seed mixtures. Seed mixtures that produce stands that range from 30 to 75 cm in height at maturity are recommended. The height of the vegetation should vary across the stand. This can

be accomplished by planting different seed mixtures in different parts of the field. This recommendation also applies to shrub plantings. Sagebrush seed should be planted in selected areas, including draws, north slopes, and benches where snow may accumulate and protect the young plants from browsing by wild ungulates. All types of sagebrush establish better by broadcast seeding. Seeds should not be placed more than 0.63 cm deep, and the soil surface should be compacted or made firm by harrowing, chaining, or compact rolling (Monsen 2005). It is best to reduce the seeding rate of grasses and forbs or not to plant them at all where sagebrush seed is distributed. This will reduce competition and increase the chances of the sagebrush seed germinating and becoming established. Grasses and forbs from adjacent areas should eventually fill in beneath the sagebrush.

Without periodic disturbance, CRP stands in Region 2 may become less vigorous, forb abundance may decline, and excess litter may accumulate. Each of these outcomes will diminish the suitability of the stand for CSTG. Therefore, stand management (i.e., burning, grazing, haying, interseeding, and disking) may be necessary, but management should only be implemented when it is consistent with the wildlife, water quality, and conservation objectives of CRP. In Region 2, most CRP stands should only require disturbance once every 10 years. Burning and haying may damage or kill sagebrush. Thus, neither activity is recommended as a means of disturbance where sagebrush is established in the stand, unless the sagebrush occurs in patches and can be avoided when burning or haying. This is one reason why sagebrush seed should be planted in patches rather than uniformly distributed across the field. Haying should not occur until the stand is firmly established. This may require three to five years. Haying of CRP lands within the occupied range of CSTG in Region 2 should not occur between 20 March and 1 August, which coincides with the breeding, nesting, and primary brood-rearing periods. No more than 50 percent of a stand should be hayed at one time, and different portions of the field should be hayed each time. At least five years should occur between haying events.

Grazing of most CRP fields within the occupied range of CSTG in Region 2 is generally not an option due to the lack of water and fencing. Development of water sources and construction of new, permanent fences in CRP fields should be discouraged. Instead, landowners wanting to graze CRP fields should consider hauling water and using temporary electric fencing where possible. Only light to moderate (25 to 40 percent utilization) grazing should be allowed. No grazing should occur before 15 July, and livestock should be removed by 15 September. At least five years should occur between grazing events. Grazing should not be allowed in addition to haying. When grazing CRP, there is the potential for livestock to move into adjacent native cover types. The livestock may actually prefer the native cover over the CRP stand, especially if the stand is dominated by sod-bound, decadent grasses. This may result in overgrazing of the native cover and failure to achieve the desired disturbance within the CRP stand. Salting, placement of water sources, and temporary electric fencing can be used to address this problem. If cattle cannot be excluded from native habitats when attempting to graze CRP stands, then grazing should not be permitted.

Managed haying and grazing should not be at the discretion of the landowner. Approval to conduct managed haying or grazing should be based on whether the field needs management to enhance the diversity and vigor of the stand. In many cases, it may not be necessary to hay or graze a field at all over the course of a 10-year contract. Heavy, periodic use by wild ungulates may be enough to maintain the vigor and diversity of the stand.

Emergency haying or grazing may be authorized anytime at the state or national level to provide relief to livestock producers in areas affected by severe drought or other natural disasters. Emergency haying and grazing generally have negative implications to wildlife because food and cover are removed when they are already in short supply due to poor growing conditions (i.e., drought). Under no circumstances should landowners be allowed to hay or graze more than 50 percent of the field under the emergency provision. If emergency haying or grazing must be applied, such events should count as part of the managed haying and grazing cycle and should not become additive to managed haying or grazing events.

Haying and grazing tend to remove excess litter. Since excess litter removal is essential for successful interseeding of legumes in CRP, Rodgers and Hoffman (2005) suggested that emergency and managed haying or grazing could provide an opportunity to enhance CRP stands lacking vegetation diversity. Stand improvement could be encouraged by forgiving the 10 or 25 percent payment reduction to the landowner for emergency and managed grazing or haying, respectively, if in return the landowner enhances the affected area.

In October 2004, the National Wildlife Federation and several of its state affiliates filed a lawsuit in the U.S. District Court for the Western District of Washington

challenging certain provisions of managed haying and grazing on CRP lands. Specifically, the lawsuit challenged the frequency allowed for managed haying and grazing on CRP acreage and the dates set to define the primary nesting and brood-rearing seasons when haying and grazing are prohibited. A settlement was reached in September 2006 (http//:www.fsa.usda.gov/Internet/FSA_file/353646-pdf, accessed 9 May 2007). The settlement is limited to certain states and applies to new contracts, including re-enrollments in those states approved after 25 September 2006. The settlement also applies to contract extensions in those states approved after 25 September 2006 if the participant had not previously been approved under the CRP contract for managed haying and grazing. The settlement does not pertain to emergency haying and grazing. Terms of the settlement that apply to CSTG range in Region 2 are as follows:

- The frequency of managed haying is limited to no more than once every 10 years

- Only 50 percent of the field can be hayed at one time, with the other 50 percent not eligible for haying for at least five years. For example, if 50 percent of the field is hayed in year 3, the other 50 percent cannot be hayed until year 8. The landowner is not required to hay 50 percent each time. However, once they have hayed 50 percent of the field, they must wait five years to hay the other 50 percent. For example, if they hay 25 percent in year 3 and another 25 percent in year 4, the remaining 50 percent is not eligible for haying until year 9

- Managed grazing is limited to no more than once every five years. Landowners may graze 100 percent of the field at no more than 75 percent of the Natural Resource Conservation Service determined stocking rate

- Managed haying and grazing are not allowed from 15 March to 15 July during each calendar year

- Managed haying and grazing may not begin until the cover is fully established.

The new rules are an improvement over the old rules, which allowed managed haying and grazing every three years, provided the field was not hayed or grazed under the emergency provision during the previous two years. However, a major problem with the old rules was not addressed. Under the new rules, managed haying or grazing is still allowed regardless of whether the field is in need of management. The only requirement is that the cover must be fully established. Fields that are fully established may provide ideal habitat for CSTG for several years before their suitability starts to decline. Prematurely haying or grazing these fields may diminish their suitability for CSTG.

A greater proportion of CRP lands surrounded by large blocks of agricultural lands should be shifted to localities near native cover types. These new CRP blocks will complement existing native habitats by creating habitat mosaics that will benefit CSTG far more than isolated blocks of CRP. This goal could be accomplished through modification of the Environmental Benefits Index.

Ecologically appropriate CRP stand enhancement should be required for future re-enrollment of stands in poor condition. This may involve complete elimination of stands comprised almost entirely of aggressive, non-native grasses, such as smooth brome. Monsen (2005) describes the steps necessary to accomplish this task successfully.

National Priority Areas are regions of the country designated by the FSA as having severe adverse water quality or habitat issues. Columbian sharp-tailed grouse currently occupy less than 10 percent of their former range due to the loss and degradation of shrubsteppe, mountain shrub, and riparian shrub cover types in the western United States. Within the same general area, the loss and degradation of sagebrush types have resulted in greater and Gunnison sage-grouse disappearing from approximately 50 and 90 percent of their former ranges. This clearly is a severe habitat issue and should be justification for establishing a National Conservation Priority Area within the sagebrush and mountain shrub rangelands in the western United States.

Farm Service Agency leaders and congressional representatives should be informed about the importance of CRP to wildlife in the West and the potential consequences if the program is discontinued or if priorities are shifted to other areas. Agencies responsible for administration of the program must be allocated adequate funds to insure that participants are in compliance with conditions of their contracts and, where necessary, to levy penalties when the rules are violated. County committees, county commissioners, producers, and agricultural businesses should be encouraged to support and approve waivers to increase the allowable CRP acreage within their counties. Funding sources

should be established to assist landowners willing to plant seed mixtures that benefit wildlife. It is critically important that state and federal wildlife agencies and conservation organizations work closely with the FSA to optimize the conservation benefits of CRP for wildlife. Towards this end, wildlife agencies and conservation organizations should provide whatever assistance the FSA needs to develop, implement, and expand new CRP practices that benefit wildlife, such as the State Acres for Wildlife Enhancement (SAFE) initiative. This initiative further extends the conservation benefits of CRP by directly addressing the needs of endangered, threatened, and other high-priority wildlife species. Every effort should be made to maximize the acreage enrolled in this program within the occupied range of CSTG in Region 2.

Oil and gas development: It is imperative that a law similar to the Surface Mining Control and Reclamation Act be developed and passed to regulate oil and gas development on federal and state lands. This law should apply to any lands where the federal government or states own the mineral rights. It should include criteria for identifying areas that should be off-limits to oil and gas development. It also should provide for a level of bonding to insure that appropriate reclamation is completed. The law should set forth minimum uniform requirements for all oil and gas activities to minimize disturbances and adverse impacts on fish, wildlife, and related environmental values, with restoration of land and water resources as the number one priority. A separate entity outside the oil and gas commission should be established within state governments whose primary responsibility is to enforce the law and to regulate the oil and gas industry.

The following recommendations are based on principles developed by a working group of the Theodore Roosevelt Conservation Partnership. Participants on the working group included representatives from the American Sportfishing Association, Association of Fish and Wildlife Agencies, Izaak Walton League of America, North American Grouse Partnership, Rocky Mountain Elk Foundation, Wildlife Management Institute, and The Wildlife Society. The recommendations are intended as a guide for dealing with energy development on public lands in the West.

- The administration and Congress should pass legislation to establish a new, long-term, dedicated funding source to adequately provide BLM, USFS, and state fish and wildlife agencies the necessary means to monitor, evaluate, and protect habitats and wildlife populations affected by oil and gas development.

- Funding appropriated for fish and wildlife management should be used to manage habitats and populations proactively. Much of the funding the BLM receives for fish and wildlife biological services is being directed to processing permits for expanded energy development.

- Annual or short-term increases in federal funding for energy development should be matched by funding to monitor and mitigate the consequences to the environment.

- A specific "conservation strategy" for each energy field or project that would go beyond the National Environmental Policy Act (NEPA)-level evaluations and plans currently being conducted should be used to proactively address wildlife needs. The conservation strategy should be finalized before development starts and must provide specific recommendations and actions to minimize impacts, while establishing plans for mitigation, restoration, monitoring, and adaptive management.

- Managers, industry, and other decision makers must be held accountable and responsible for following laws, regulations, and policy including commitments made in NEPA documents. A process for accountability that allows the public to track compliance with law, policy, plans, and commitments made in decision documents should be established.

- Compliance with, and enforcement of, requirements from Records of Decision should be included in the written performance standards for federal employees responsible for each phase of the energy development process.

- Operational compliance and performance should be linked to lease rights. Thus, if operators do not comply with the provisions/stipulations of their operating permit, they would be in violation of the lease, and cessation of drilling activities would be warranted.

- Mineral leasing should be done in a manner that takes into account the future impacts from development on wildlife resources. This requires a change in the current leasing process that would provide for a prior assessment of impacts from lease development before leasing occurs.

- Public involvement from all stakeholders should be assured.

- Federal officials must use adaptive management based on the best available information and coordinate with state agencies. An effective adaptive management process must include regular reviews of both state and federal findings from research and monitoring, active consideration of alternative energy field management, and the means for making management changes for future development where needed to lessen impacts to wildlife.

- A clear, open federal planning process and decision-making process that follows administrative law is essential.

- Leasing and development should be guided by complete and current land use plans developed with public review, based on current information on how development is likely to proceed.

- Federal land managers must make decisions on energy development following processes that allow for adequate public review. Sufficient information about proposed energy leases and development must be provided to the public to allow for understanding and reasonable comments. The time for public comment must be commensurate with the complexity of the proposal.

- Meetings related to energy development on public lands should be part of the public record.

- The energy development planning process should include science-based mitigation and an adaptive management process that uses the most rigorous data available to adjust development. Off-site mitigation is essential when on-site mitigation cannot be effectively used or is inappropriate to offset resource values impacted at the project location.

- Off-site mitigation that only involves improving existing habitats outside the impacted area should not be acceptable. Off-site mitigation should be equal to the area rendered unsuitable due to oil and gas activity. For instance, if 200 ha of occupied habitat are rendered unsuitable for CSTG, the appropriate mitigation should be to create or restore 200 ha of habitat somewhere else, preferably within 2 km of the impacted site. The success of the mitigation should be measured based on whether the newly created habitat is used by CSTG. Off-site mitigation should be in addition to reclamation requirements on the impacted site.

- There are certain special and unique places that should be entirely off-limits or extremely limited to oil and gas development.

The Wyoming Game and Fish Department (2004) has prepared a working document to assist managers in dealing with oil and gas issues (available at http://gf.state.wy.us/wildlife/index.asp, accessed 6 December 2006). This document includes a comprehensive list of standard management practices and mitigation options to reduce the impacts associated with oil and gas development. Information contained in the document is directly applicable to Region 2. The Wyoming document is adapted from a BLM publication entitled "Best Management Practices for Oil and Gas Development on Public Lands" (available at http//:blm.gov/bmp/, accessed 6 December 2006). However, the Wyoming document contains more specific criteria and better defines the circumstances and extent to which the management practices and mitigation options should be applied to protect wildlife resources and habitat functions. As a working document, the recommendations are updated and revised as relevant new information becomes available.

Loss of habitat: Protecting 100 percent of the remaining habitats occupied by CSTG in Region 2 is desirable, but unrealistic due to the preponderance of habitat occurring on private lands. Maintaining, improving, and possibly creating new habitats on public lands should be pursued to compensate for loss of habitats on private lands. With proper management, potentially suitable habitats on BLM and USFS lands in

southwestern Colorado, west-central Colorado, north-central Colorado, and southwestern Wyoming could support viable populations of CSTG. Public lands should receive the highest priority for protection, enhancement, and restoration of native plant communities.

A certain level of habitat loss within the occupied range of CSTG in Region 2 can occur without adversely affecting the stability of the population. However, proper planning and cooperation among all parties involved are critical. County planners and county commissioners should be informed about the status, distribution, and habitat requirements of CSTG so they can make sound decisions regarding development proposals and request appropriate mitigation measures. County planners and commissioners should be encouraged to develop a consistent process of sending development proposals to local state wildlife agency representatives for comment. In turn, state wildlife agencies should provide the counties with the most recent and accurate information on location of leks and other critical habitats, and identify areas where new construction could potentially fragment populations. Wildlife agencies should work with planners and county commissioners on development and modification of land use and zoning plans to protect critical CSTG habitats. Agency representatives should be present at county commission and planning meetings to provide testimony and offer suggestions to avoid, minimize, correct, or mitigate impacts of development on CSTG. State wildlife agencies and county governments should offer incentives to developers who protect and enhance CSTG habitats. Cluster development, density credits, development right transfers, land exchanges, open space, conservation easements, and fee title acquisition should all be considered as mechanisms to minimize or prevent loss of CSTG habitats. This must be done in a manner that balances the need to conserve habitats for CSTG with the rights of private property owners to develop their land.

Utility companies also should be provided with the most recent information on location of leks and other critical CSTG habitats, and they should be encouraged to place lines underground. Abandoned utility lines should be removed, and construction of new utility lines should be done within existing corridors or along roads whenever possible. Overhead utility lines near leks and other critical CSTG habitats should be appropriately marked to minimize collisions and fitted with devices to deter perching by raptors.

Construction of new roads should avoid CSTG habitats where possible or at the very least avoid direct line of sight between known leks and road traffic. Speed limits should be set to reduce vehicle collisions with grouse and other wildlife. Managers should consider options such as seasonal use restrictions, closure, removal, or realignment of non-essential roads on public lands that occur near leks or traverse nesting, brood-rearing, or winter habitats. Any roads constructed across public lands for the sole purpose of oil, gas, or coal exploration and extraction should be removed and the roadway seeded with native vegetation after the activity is completed.

Hunting: State wildlife agencies should not knowingly allow overharvest of CSTG on public lands under the pretense that these lands are repopulated by grouse from surrounding private lands that are unhunted or lightly hunted. This rationale portrays a poor image to the non-hunting public and discourages other user groups from changing their practices to benefit CSTG. It also may not be a biologically sound rationale for CSTG, where the overall range has been drastically reduced and remaining habitats face multiple threats of further loss and degradation. Hunting of CSTG in northwestern Colorado is an acceptable use of the resource, but solutions must be sought to reduce hunting pressure and harvest on public lands. Possibilities include leasing more State School Lands for public hunting, implementing a permit system to limit hunter participation, setting shorter seasons that open later in the fall, setting the possession limit equivalent to the bag limit (i.e., possession and bag limit = 2 grouse per hunter per season), and changing the legal time hunting can begin in the morning to 0900 to discourage hunters from shooting birds on or near leks.

Hunting of transplanted populations should only be considered when lek counts indicate a minimum of 200 males in the population. Hunting should only be allowed on a limited permit basis designed to remove no more than 10 percent of the estimated fall population. More liberal seasons can be approved as populations increase and expand their range.

State wildlife agencies should explore new ways to increase the precision of harvest surveys for grouse. The biggest problem is identifying the sampling universe (i.e., those small game license buyers that actually hunt grouse). One recommended solution to this problem is to issue a separate license for grouse hunting. This recommendation has not received wide support from agency administrators. The Hunter Information Program (HIP) attempts to identify the sampling universe for some game birds, including CSTG, by asking hunters to indicate what game birds

they are likely to hunt when they register with the program. The reliability of this approach in identifying CSTG hunters has not been tested, and only a portion of the hunters that indicate they plan to hunt CSTG are sampled. Until a more reliable means of identifying CSTG hunters is available, 100 percent of the hunters registering with the HIP that say they are very likely to hunt CSTG should be sampled.

Captive-rearing: Captive-rearing of grouse for release into the wild has not proven to be a successful management tool and should only be considered as a last resort to prevent extinction (Storch 2000). Grouse are difficult to breed and raise in captivity because of their complex behaviors, special requirements, and vulnerability to diseases and parasites when placed in captive situations (Johnsgard 1973). Captive-rearing is labor-intensive and costly, but most importantly, grouse raised in captivity rarely survive and reproduce when released into the wild (Storch 2000). In Germany, four release projects for black grouse and nine for capercaillie involving several thousand birds failed to establish a single self-sustaining population (Klaus and Bergmann 1994, Klaus 1997). Efforts to raise sharp-tailed grouse in captivity for release into the wild were abandoned in Michigan due to difficulties in raising birds to maturity (Ammann 1957). Although Attwater's prairie chickens are currently being successfully bred and raised in captivity, their survival in the wild has been extremely low (Lockwood 1998, Silvy et al. 1999). Continued supplementation has been necessary, with no indication that the captive-bred birds are capable of establishing a self-sustaining wild population. With the exception of the Attwater's prairie-chicken, release of captive-reared birds should not be a conservation priority for any grouse species in North America. In most cases, when it becomes necessary to resort to captive breeding, it is because suitable habitats of sufficient size and suitability are no longer available to support a self-sustaining wild population. At this point, release of captive reared birds has little or no chances of success. According to the International Union for Conservation of Nature and Natural Resources (1987) policy statement on captive breeding, the establishment of captive populations as a long-term conservation strategy to reduce the risk of extinction is only recommended when a taxon has declined to less than 1,000 individuals in the wild. Columbian sharp-tailed grouse are in no immediate danger of reaching this critically low level. Adequate numbers remain in British Columbia, Idaho, Utah, and Colorado to support reintroduction and augmentation programs using wild-trapped birds of the appropriate genetic stock.

Predator control: Predator control is rarely recommended as a tool for management of North American grouse (Hewitt et al. 2001, Schroeder and Baydack 2001). This is due to numerous factors including lack of information on the long-term consequences of predator control, the relatively high cost of predator control, the protected status of many potential predators, and concerns about public attitudes towards predator control (Messmer et al. 1999). Predator control to increase production and recruitment of sharp-tailed grouse would need to occur over broad geographic areas and target a large suite of predators to be effective. Even then, the program would need to be ongoing; otherwise, the benefits would be minimal and only last a short time. Certain predators of grouse are easier to control than others are, and many of the avian predators are protected by law and cannot be controlled. The result may be predator exchange (i.e., removing one predator may increase densities and predation rates of another predator) with no net decrease in predation rates (Parker 1984, Greenwood 1986).

The entire predator control issue is compounded because predator/prey relationships are extremely complex and difficult to study. Hoffman (2001) noted that any attempts to evaluate the success or failure of predator control will be fraught with problems. The data will most likely be inconclusive, open to broad interpretation, and will have limited application because predation patterns in one portion of the range seldom mimic patterns in another portion of the range. Predator management for sharp-tailed grouse is better addressed by protecting and manipulating habitats and reducing or modifying factors that facilitate predation (Hoffman 2001). However, if habitats for CSTG become more fragmented and altered and populations become more threatened or endangered, it may be necessary to reconsider predator control as a management tool and to evaluate its viability through experimentation (Schroeder and Baydack 2001).

Information Needs

Connelly et al. (1998) identified the following priorities for research on sharp-tailed grouse:

- develop effective management strategies to stabilize and ultimately increase populations that are declining or failing to expand their range

- improve our knowledge on the effects of hunting

- ❖ improve our understanding of the genetic relationships among individuals, populations, and metapopulations

- ❖ improve our understanding of the lek mating system of sharp-tailed grouse.

The recommendations by Connelly et al. (1998) are applicable to CSTG in Region 2.

Studies in Region 2 have provided baseline information about the status, distribution, general life history, and ecology of CSTG, but additional studies are needed to compliment this information. Many basic life history traits of CSTG in Region 2, such as seasonal food habits, chick survival and recruitment, winter habitat use patterns, and lek attendance patterns, remain poorly studied. Some of this information has been collected on other subspecies of sharp-tailed grouse and on CSTG populations outside of Region 2. It is uncertain whether this information fully pertains to CSTG in Region 2. For instance, movements, population dynamics, and habitat use patterns of CSTG in Washington, where populations are small and isolated from each other, may not be the same for the larger, more contiguous population in northwestern Colorado and south-central Wyoming. Information from studies outside of Region 2 should be interpreted and used with caution in formulating management strategies for CSTG in Region 2.

Uncertainty remains about the distribution and status of CSTG in Region 2, particularly in Wyoming. The Wyoming Game and Fish Department attempts to count CSTG leks, but efforts are not consistent from year to year, and at times, counts are late in the breeding season because surveys of greater sage-grouse take precedence. It is imperative for conservation planning purposes in Region 2 that the Wyoming Game and Fish Department make a concerted effort to count known leks and to conduct searches to locate new leks.

The presence or absence of CSTG in Mesa County, Colorado also needs to be confirmed. The last sightings were in 1985 on the north end of the Uncompahgre Plateau (Giesen 1985). Subsequent efforts to find CSTG in this area have been unsuccessful. However, the searches were conducted after the peak of breeding activities when small leks may have easily gone undetected. Additional searches should be conducted during the peak of breeding activities from mid-April to early May to be certain CSTG no longer occur in Mesa County.

Potential reintroduction sites have been identified in Colorado, and transplant programs are currently in progress. An evaluation of potential reintroduction sites has not been conducted in Wyoming. Areas that need to be searched and evaluated include portions of Uinta, Lincoln, and possibly Teton counties near the Utah (Uinta and Lincoln counties) and Idaho (Lincoln and Teton counties) borders. Remnant populations may still exist in these areas, or more likely, sharp-tailed grouse from established populations in Utah and Idaho may occasionally pioneer into extreme southwestern and western Wyoming, but in insufficient numbers to establish a population.

Before transplants are conducted in Wyoming, the genetic status of CSTG in northwestern Colorado and south-central Wyoming should be confirmed. Preliminary evidence suggests that CSTG in northwestern Colorado are genetically dissimilar from other populations of CSTG. More samples need analyzed from Colorado to confirm the preliminary findings. Since the south-central Wyoming population is contiguous with the northwest Colorado population, CSTG in south-central Wyoming may very well be genetically different from other populations. This is speculation and needs further study and confirmation. Sharp-tailed grouse captured in Idaho or Utah may prove to be a better source of transplant stock for southwestern and western Wyoming than birds from Colorado or south-central Wyoming.

Cannon and Knopf (1981) found that for lesser prairie-chickens surveyed over large areas, the number of active leks exhibited a strong positive correlation ($r = 0.94$) with density of displaying males (number per 100 ha) and only a weak correlation ($r = 0.75$) with average lek size. In essence, as populations increase, males exhibit a greater tendency to form more leks than to increase the size of existing leks. This may be happening with CSTG in northwestern Colorado. It may be that fidelity to natal areas is strong in CSTG. Rather than pioneering into unoccupied habitats during periods when populations are increasing, CSTG may form more leks. Studies are needed to better understand the lek dynamics of CSTG during periods when populations are increasing and decreasing. Documenting when, where, and how juvenile grouse become established on leks should be a major objective of these studies.

Because CSTG in Routt and Moffat counties are not expanding on their own, the CDOW has proposed transplanting grouse into areas adjacent to occupied

habitats. However, it is uncertain how far birds must be moved before they will not attempt to return to where they were captured. Attempts to collect this information must be included as part of any transplant program.

For effective conservation of CSTG, a better understanding is required of how the subspecies responds to alterations in habitat and changes in environmental conditions. To obtain this knowledge, it will be necessary to implement longer-term studies than have been conducted to date. Long-term data sets are needed to capture a suitable amount of environmental stochasticity to conduct a reliable population viability analysis. Long-term studies also are essential to better understand the factors that regulate CSTG populations. A prerequisite to this understanding is the need to develop a standardized, statistically valid technique to monitor population densities of CSTG. This information traditionally has been collected using lek counts, but no attempt has been made to understand the lek attendance patterns of CSTG. It is unknown whether all males attend leks or how consistently they attend leks. It is generally accepted that males only attend one lek, but even this has not been confirmed for CSTG. Likewise, it is assumed that all females attend leks, but since females are only captured and counted on leks, it is unknown whether this assumption is true. Another assumed characteristic of CSTG populations is that the sex ratio is essentially 1:1. This assumption is based on wing samples collected during the fall hunting season, which may not be representative of the population.

Biologists and land managers must have a comprehensive knowledge of the seasonal habitat requirements and temporal patterns of resource selection of CSTG to develop and carry out management programs effectively. Several studies in Region 2 have attempted to collect this information (Oedekoven 1985, Giesen 1987, Klott 1987, Boisvert 2002, Collins 2004), but more comparative studies are needed on how CSTG use and perform (survival, reproductive success) within and among the different habitat types they are known to use for breeding, nesting, and brood-rearing. For instance, CSTG are known to use CRP in Region 2 for lek sites (Hoffman 2001). They also have been documented nesting and raising broods in CRP in Region 2 (Boisvert 2002). However, Hoffman (2001) postulated that CSTG may perform better in some CRP fields than others depending on the composition and structure of the vegetation within the fields as noted for lesser prairie-chickens in Kansas (Fields 2004). This aspect of CSTG ecology still needs to be investigated.

Little is known about the distribution and habitat use patterns of CSTG in Region 2 during winter other than general descriptive information. More effort needs to be directed at identifying and mapping known wintering areas. Boisvert et al. (2005) recommended that additional studies are needed to ascertain why CSTG breeding in mine reclamation and CRP move long distances to use specific areas during winter when other apparently suitable areas closer to leks are by-passed. This does not appear to be the case for CSTG breeding in native shrubsteppe (Collins 2004). Additional studies of CSTG in native shrubsteppe are necessary to confirm the findings of Collins (2004).

Food habit studies have primarily focused on the adult segment of the population using techniques (e.g., fecal analysis, observations of feeding birds, and observations of sign) that may not accurately reflect diet composition. No food habits studies of CSTG have been conducted in Region 2. Studies in Colorado suggest that the brood-rearing period may be a critical time of year for CSTG using native shrubsteppe (Boisvert 2002, Collins 2004). It is unknown whether the problem is related to habitat quality, food availability, or both. Knowledge regarding the food habits of CSTG chicks from time of hatch until they start eating the same foods as adults would be helpful in addressing this issue. In addition, knowledge of the foods important to adult CSTG during spring, summer, and fall is essential for directing management efforts to restore native habitats, for developing seed mixtures for CRP plantings, and for providing recommendations to the energy industry for improving reclamation seed mixes. Additional knowledge also is required about the influence of nutrient levels and secondary compounds on food selection and whether food selection patterns differ by gender. Evidence suggests that CSTG in Region 2 are highly dependent on serviceberry for food during winter, but it is unlikely that all serviceberry plants are equally valuable as food. An understanding of the physical and chemical attributes of serviceberry that CSTG select as food is critical to protecting and managing winter habitats.

Hunting as a possible factor suppressing CSTG populations on public hunting areas will likely become a contentious issue in the future. The merits of hunting are being increasingly challenged by the non-hunting public. It is imperative that state wildlife agencies have strong biological justification for hunting any species. It is difficult for some members of the public to understand how the CDOW can continue to authorize hunting seasons on CSTG when it has been petitioned

twice for federal listing. The extent to which hunting is compensatory or additive remains debatable. Definitive experiments are needed to resolve this debate. Accordingly, there must be an ongoing effort to increase the precision of harvest estimates. Better information is needed on the distribution of the harvest so potential problem areas can be identified and regulations enacted to protect against overharvest. An effort must be made to determine if populations on public hunting areas are self-sustaining or maintained by immigration of birds produced on surrounding private lands that are unhunted or only lightly hunted.

New studies on CSTG should focus on applied research and move from descriptive, correlative, short-term work on small geographic areas, to large-scale, long-term experiments that include treatments, controls, and replications. Data derived from such studies are lacking for CSTG. Well-designed experimental studies are essential for understanding the effects of grazing, energy development, urbanization, fire, recreation and other human-related activities on CSTG populations and habitats. Ideally, these studies should be conducted in collaboration with scientists from other disciplines and with scientists working on other species of wildlife that live in association with CSTG. The recommendations resulting from these studies must be tested through well-designed experiments to evaluate their effectiveness in achieving the desired outcome (adaptive management). It is only under this scenario that recommendations can be developed for managing CSTG populations and their habitats. Recommendations developed under this scenario will have greater credibility and support among decision makers, and most importantly, a higher likelihood of being implemented than recommendations based only on descriptive studies.

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GUIDELINES FOR MANAGEMENT OF COLUMBIAN SHARP-TAILED GROUSE HABITATS

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Populations and distribution of Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) have declined in western North America since the beginning of this century (Hart et al. 1950, Miller and Graul 1980, Kessler and Bosch 1982). This subspecies presently occurs in British Columbia, Washington, Idaho, Montana, Utah, Wyoming, and Colorado (Aldrich 1963, Miller and Graul 1980); it has been extirpated from Oregon (Olsen 1976, Evanich 1983), California (Starkey and Schnoes 1976), and Nevada (Wick 1955). Except in

British Columbia, where little is known about population size, this subspecies exists as isolated populations inhabiting <10–50% of its former range (Miller and Graul 1980). Columbian sharp-tailed grouse are designated as a Category 2 species by the U.S. Fish and Wildlife Service (U.S. Dep. Int. 1989) under the Endangered Species Act.

Vegetative communities associated with historical and current distributions of Columbian sharp-tailed grouse (Aldrich 1963) include sagebrush steppe (*Artemisia-Agropyron*), mountain mahogany-oak scrub (*Cercocarpus-Quercus*), fescue-wheatgrass (*Festuca-Agropyron*), and wheatgrass-bluegrass (*Agropyron-Poa*), described by Kuchler (1964), and riparian and mountain shrub. We define a mountain shrub community as a site dominated by ≥1 deciduous shrub including serviceberries (*Amelanchier* spp.), snowberries (*Symphoricarpos* spp.), common chokecherry (*Prunus virginiana*), and Gambel oak (*Q. gambelii*).

Numerous factors have been implicated in the decline of Columbian sharp-tailed grouse. Conversion of native rangelands to cropland, excessive grazing by livestock, herbicide treatments, removal of trees in riparian zones, invasion of conifers, and urban development have been identified as primary factors (Hart et al. 1950, Yocom 1952, Buss and Dziedzic 1955, Marshall 1969, Starkey and Schnoes 1976, Zeigler 1979, Leatham and Roberson 1980, Bredehoft 1981, Evanich 1983, Oedekoven 1985, Marks 1986, Giesen 1987, Klott 1987, Marks and Marks 1987, I. Ohanjanian [Bioquest Int. Consulting, Kimberly, B.C., unpubl. rep., 1990]). Increasing human activities within the historical range of Columbian sharp-tailed grouse will likely exacerbate the loss of sharp-tailed grouse habitats through additional excessive grazing, conversion of rangeland to cropland, mineral exploitation, and expansion of residential developments and associated recreational areas.

The Western Sage and Sharp-tailed Grouse Committee, under the auspices of the Western Association of Fish and Wildlife Agencies, has increasingly become concerned about population declines of Columbian sharp-tailed grouse as well as loss and fragmentation of this species' habitat. Thus, we provide a synopsis of Columbian sharp-tailed grouse ecology and habitats and present guidelines for identification, protection, and maintenance of these habitats.

HABITAT REQUIREMENTS

Food Habits

Knowledge of food habits and nutritional requirements of Columbian sharp-tailed grouse are inadequate. There have been no detailed studies of food habits of Columbian sharp-tailed grouse chicks, but anecdotal evidence indicates that insects constitute a major portion of their diet (Parker 1970, Johnsgard 1983). Adult diets in spring and summer encompass a variety of vegetative material including salsify (*Tragopogon* spp.), creeping barberry (*Berberis repens*), common dandelion (*Taraxacum officinale*), sagebrush buttercup (*Ranunculus glaberrimus*), bluegrasses (*Poa* spp.), bromes (*Bromus* spp)., other grass seeds and leaves, and insects including Coleoptera, Hymenoptera, and Orthoptera (Marshall and Jensen 1937, Hart et al. 1950, Jones 1966, Parker 1970). Fall diets are similar, but include a higher portion of insects and agricultural crops, especially wheat, where available (Marshall and Jensen 1937, Jones 1966).

Winter foods include fruits and buds of deciduous trees and shrubs including chokecherries, serviceberries, hawthorns (*Crataegus* spp.), snowberries, aspens (*Populus* spp.), willows (*Salix* spp.), birches (*Betula* spp.), and wild roses (*Rosa* spp.) (Marshall and Jensen 1937, Dargan et al. 1942, Hart et al. 1950, Buss and Dziedzic 1955, Jones 1966, Rogers 1969, Zeigler 1979, Marks and Marks 1988). Winter dependence on deciduous trees and shrubs for food and cover may limit Columbian sharp-

tailed grouse within the sagebrush-steppe habitat; loss of this habitat component has been associated with declining populations in Utah (Hart et al. 1950) and Washington (Zeigler 1979).

Movements and Home Range Size

Spring and summer movements of Columbian sharp-tailed grouse are typically restricted within a relatively small home range. Nests have been located <100 m (Marks and Marks 1987) to >3 km (Meints 1991) from lek (dancing ground) sites, with most females nesting ≤1.6 km from the lek where they were trapped (Bredehoft 1981, Oedekoven 1985, Marks and Marks 1987, Meints 1991).

Most broods, as well as adult males, remained ≤1.6 km from leks (Marshall and Jensen 1937, Parker 1970, Bredehoft 1981, Oedekoven 1985, Giesen 1987, Klott 1987, Marks and Marks 1987, Klott and Lindzey 1990, Meints 1991). The daily summer cruising radius for sharp-tailed grouse in Utah and Idaho ranged from <100–400 m (Hart et al. 1950, Meints 1991). The monthly median dispersion from lek of capture was greater for females than males during May through August in Colorado (Giesen 1987) with monthly median distances ranging from 0.2–0.6 km for males and 1.1–1.6 km for females. Few locations (<10%) were >2.5 km from lek of capture (Giesen 1987). Meints (1991) reported that Columbian sharp-tailed grouse broods in eastern Idaho used habitats farther from leks ($\bar{x}$ = 825 m) than did males ($\bar{x}$ = 475 m).

Average spring-to-fall home ranges ranged from 1.0 km^2 in Colorado (Giesen 1987) to 1.9 km^2 in Idaho (Marks and Marks 1987). A 95% probability ellipse of all radio locations including nest sites, brood-rearing habitats, and summer ranges of male and female Columbian sharp-tailed grouse was calculated to have a 2.05-km radius around lek sites in Colorado (Giesen 1987).

Movements of marked Columbian sharp-tailed grouse between breeding areas and winter range ranged from 2.6 km in western Idaho (Marks and Marks 1987) to 4.5 km in northwestern Colorado (Giesen 1987), but Meints (1991) documented movements of 20 km for 2 females in southeastern Idaho. Columbian sharp-tailed grouse seem to move farther to wintering habitats in regions lacking a broad distribution of winter food resources.

Lek Site Characteristics

Characteristics of Columbian sharp-tailed grouse leks often have been studied because they are important for mate selection and breeding, and typically are adjacent to nesting and brood-rearing areas. Leks also are a focal point in management of sharp-tailed grouse because of their use in population surveys. Disturbances to leks may result in regional declines in sharp-tailed grouse populations (Baydack and Hein 1987).

Leks typically are located on knolls, ridgetops, or benches that are higher than surrounding topography (Marshall and Jensen 1937, Hart et al. 1950, Rogers 1969, Parker 1970). Reported elevations ranged from 1,835–2,780 m in Colorado (Rogers 1969) to 2,100–2,460 m in Wyoming (Oedekoven 1985), but varied considerably with latitude. These sites have been characterized as having thin, rocky, easily eroded soils, or as claypan that supports sparse vegetation (Rogers 1969). Land use at leks has been characterized as native rangeland used for livestock grazing (Marshall and Jensen 1937, Hart et al. 1950, Rogers 1969, Oedekoven 1985). However, about half the leks located in Colorado were in cultivated areas including alfalfa, hay, wheatgrasses, or dryland wheat-fallow rotations (Rogers 1969).

Leks of Columbian sharp-tailed grouse often have taller vegetation and more shrub cover than leks of other subspecies of sharp-tailed grouse, and males occasionally have been observed displaying on shrubs (Rogers 1969). Lek

sites have been described as grassy or weedy areas in shrubland; however, sagebrush, Gambel oak, snowberry, and other shrubs often obscure displaying males (Marshall and Jensen 1937, Hart et al. 1950, Rogers 1969, Bredehoft 1981, Ward 1984, Oedekoven 1985). Average shrub height measured on lek sites in Wyoming was 36 cm, with a density of 10,778 shrubs/ha (Bredehoft 1981).

Male Columbian sharp-tailed grouse selected vegetation density with 20–30% visual obstruction on leks over other vegetative densities (Ward 1984). Ward (1984) recommended brush removal on or near leks as a management practice to maintain sharp-tailed grouse dancing grounds. Klott and Lindzey (1989) reported that lek sites of Columbian sharp-tailed grouse in Wyoming had less vegetative cover than random sites (35 vs. 68% visual obstruction). Marshall and Jensen (1937) reported that sharp-tailed grouse abandoned a large (25 males) lek site the year following a fire that removed most vegetation. Sparse vegetation on lek sites may facilitate visual courtship, but shrub cover on or adjacent to leks may provide escape cover from predators. Males may select open sites for display and mating (Ward 1984), but there is no evidence that dense cover on leks is detrimental to reproduction or survival of Columbian sharp-tailed grouse.

Nesting Habitats

Habitats selected for nesting varied among studies and available vegetative types. In Utah, where most native rangeland within the historical range of Columbian sharp-tailed grouse was converted to cropland, females selected alfalfa or wheat stubble for nesting in preference to native vegetation (Hart et al. 1950). However, nest failure in alfalfa and wheat stubble was 53 and 82%, respectively, but only 30% in rangeland (Hart et al. 1950). When native rangeland was used for nesting, most females (74–100%) nested beneath a shrub (Parker 1970, Giesen 1987, Marks and Marks 1987, Meints 1991). Shrub density at nests in eastern Idaho averaged 11,000 shrubs/ha compared to 5,000 shrubs/ha at independent sites (Meints 1991). Sagebrush, serviceberry, and snowberry were dominant shrubs at a Wyoming nest site with a density of 17,800 shrubs/ha (Bredehoft 1981). In Colorado, sharp-tailed grouse females selected relatively dense (32,500 shrubs/ha) cover, with snowberry and sagebrush the most abundant shrubs at 8 nest sites (Giesen 1987). Densities of short shrubs (<1 m tall) were 5 times greater at nest sites than at sites 10 m from nests and at random sites. Tall shrubs (>1 m tall) averaged 50% greater density at nest sites. Females apparently selected dense stands of shrubs for nesting with clumps of taller and denser shrubs at the actual nest site. Preliminary data from the Tobacco Plains in northwestern Montana indicated that nests were beneath bunchgrasses, primarily rough fescue (*F. scabrella*) and bluebunch wheatgrass (*A. spicatum*) (M. A. Wood, Mont. Dep. Fish, Wildl. and Parks, Kalispell, pers. commun., 1991). Meints et al. (1992) suggested that Columbian sharp-tailed grouse need a minimum vegetative height-density measure (Robel et al. 1970) of 2.5 dm for nesting.

Brood Rearing and Summer Habitats

Summer habitats of Columbian sharp-tailed grouse have been characterized as shrub-steppe vegetation with a diversity of forbs and bunchgrasses (Hart et al. 1950, Klott 1987, Marks and Marks 1987, Klott and Lindzey 1990) or mountain shrub habitats dominated by serviceberry and Gambel oak (Giesen 1987). Interspersion of cover types was considered important. McArdle (1977) reported that >70% of his observations were ≤30 m from the nearest habitat edge. Marks and Marks (1987) indicated that 40% of available habitats occupied by Columbian sharp-tailed grouse were ≤20 m from a habitat edge; the mean distance from flush site to mountain shrub or riparian "escape" cover was 131 m. Meints (1991) reported

a median distance of 50 m to habitat edge for Columbian sharp-tailed grouse broods in eastern Idaho. Availability of free water was not considered important to distribution of Columbian sharp-tailed grouse in summer and no evidence of its use was found (Parker 1970, Marks and Marks 1987).

Vegetative composition of summer habitats varied geographically. Summer ranges in Colorado contained ≥70% shrub cover (Giesen 1987). Snowberry and big sagebrush (*A. tridentata*) had the highest relative frequencies and densities. Snowberry had a higher importance value (Dix 1961) than any other shrub <1 m in height. The most important tall shrub was serviceberry; sharp-tailed grouse usually were associated with this shrub or with chokecherry. Summer use sites in western Idaho were primarily big sagebrush and low sagebrush (*A. arbuscula*) cover types (40 and 21% of observations, respectively) with <10% in mountain shrub or riparian communities (Marks and Marks 1987). In eastern Idaho, Columbian sharp-tailed grouse broods preferred Conservation Reserve Program (CRP) fields over native rangeland and agricultural fields (Sirotnak et al. 1991). In Wyoming, sharp-tailed grouse broods most often occurred in sagebrush-snowberry and mountain shrub communities (34 and 39% of observations, respectively). No broods were found in sagebrush-grass, aspen-riparian, or field habitats, although these habitat types comprised 51, 5, and 2% of the study area, respectively (Klott and Lindzey 1990).

Vegetative structure at summer use sites measured by visual obstruction of a vertical cover board (Jones 1968) was similar to that at random sites in mountain shrub habitats in Colorado but less in hay fields for males (Giesen 1987). In western Idaho, Columbian sharp-tailed grouse flush sites had denser cover than measured at random sites (Marks and Marks 1987); brood sites in eastern Idaho had more cover than independent sites (Meints 1991). Geographic differences may be a result of generally denser cover and more mesic conditions in Colorado, and use of mountain shrub habitats compared to sagebrush habitats in Idaho.

Shrub densities at summer use sites of Columbian sharp-tailed grouse ranged from 800–13,300 shrubs/ha for males to 4,200–24,000 shrubs/ha for females in Colorado (Giesen 1987). McArdle (1977) reported that 77% of sharp-tailed grouse observed in southeastern Idaho were in areas with 20–40% shrub canopy cover. Marks and Marks (1987) reported that Columbian sharp-tailed grouse flush sites in western Idaho in big sage and low sage habitats averaged 9% shrub canopy cover, which was higher than at random sites.

High diversity of forbs and grasses was characteristic of Columbian sharp-tailed grouse summer use sites in western Idaho (Marks and Marks 1987); such sites in Wyoming had more species of forbs and more grass cover than random sites (Klott 1987, Klott and Lindzey 1990). Native perennials including arrowleaf balsamroot (*Balsamorhiza sagittata*) and bluebunch wheatgrass, which are major indicators of late seral stages (Hironaka et al. 1983), reflected the preference of Columbian sharp-tailed grouse for relatively undisturbed areas (Marks and Marks 1987). Columbian sharp-tailed grouse also seemed to respond to livestock grazing by moving to ungrazed rangeland (Marks and Marks 1987) or by concentrating in and adjacent to ungrazed CRP lands (Sirotnak et al. 1991).

Wintering Areas

Columbian sharp-tailed grouse are associated with deciduous trees and shrubs in upland and riparian areas (Marshall and Jensen 1937; Dargan et al. 1942; Hart et al. 1950; Parker 1970; McArdle 1977; Zeigler 1979; Oedekoven 1985; Marks and Marks 1987, 1988; Meints 1991). In winter, Columbian sharp-tailed grouse often moved >5 km to find suitable food and cover (Hart et al. 1950) and movements ≤20 km have been recorded (Meints 1991). Marks and Marks (1988), however, reported that 80% of their winter observations of Columbian sharp-tailed grouse were within 2 km of leks.

Habitat requirements seem narrower in winter than in other seasons. Marks and Marks (1987) observed that all winter locations of Columbian sharp-tailed grouse were within 125 m of mountain shrub or riparian cover types and 88% of their observations were within 50 m of these 2 cover types. Meints (1991) reported a mean distance of 90 m to riparian cover in winter. McArdle (1977) reported that winter use by Columbian sharp-tailed grouse in southeastern Idaho was confined to areas of >40% shrub cover. Columbian sharp-tailed grouse roost in snow when conditions are adequate (Marshall and Jensen 1937, Hart et al. 1950, Marks and Marks 1987); deciduous trees and shrubs may serve as snow accumulation areas for roosting.

EFFECTS OF HABITAT ALTERATION

Grazing

Excessive livestock grazing is 1 factor responsible for the decline of Columbian sharp-tailed grouse in North America (Marshall and Jensen 1937, Hart et al. 1950, Parker 1970, Zeigler 1979, Miller and Graul 1980, Klott 1987, Marks and Marks 1987, Klott and Lindzey 1990). Detrimental effects of excessive grazing include removal of nesting and brood rearing cover and destruction of deciduous trees and shrubs through trampling, browsing, and rubbing (Kessler and Bosch 1982). Loss of deciduous cover is especially severe near riparian areas that attract livestock in summer because of water and shade; this cover provides critical foraging areas and escape cover for Columbian sharp-tailed grouse throughout the year (Zeigler 1979, Marks and Marks 1987). Livestock on lek sites in spring may interfere with courtship displays and breeding, but the long-term impacts of this disturbance are unknown (Parker 1970, Klott 1987). The effects of livestock grazing of upland sites on Columbian sharp-tailed grouse distribution or habitat use have not been investigated, but may not be detrimental if shrub and herbaceous cover does not decline. However, in bunchgrass-prairie habitats with limited shrub cover, residual grass cover for nesting may be critical, and grazing may reduce cover at nest sites and result in low nest success.

Herbicide Spraying

Herbicide spraying (primarily 2,4-D) of Columbian sharp-tailed grouse habitat has a negative effect on the species (McArdle 1977, Oedekoven 1985, Klott 1987) because of detrimental impacts to deciduous shrubs, especially snowberry, serviceberry, chokecherry, and hawthorn (Blaisdell et al. 1982). Impacts include immediate loss of nesting, brood, and winter cover. Recovery of shrubs and forbs may depend on intensity of livestock use following spraying.

Burning

The impacts of fire on Columbian sharp-tailed grouse are influenced by vegetation type, timing, frequency, intensity, and size of burn. Snowberry, chokecherry, and Gambel oak sprout profusely following fire but sagebrush declines (Blaisdell et al. 1982, Kufeld 1983, Monsen and Shaw 1983). Burning of wheat stubble fields resulted in loss of nests and contributed to the decline of sharp-tailed grouse in Washington (Yocom 1952, Buss and Dziedzic 1955). Hart et al. (1950) reported the abandonment of a lek site following fire, but indicated prescribed fire may be a useful management tool for opening dense stands of sagebrush and creating an interspersion of grass and shrub cover. Rogers (1969) reported Columbian sharp-tailed grouse used small openings resulting from fires in areas of dense brush. McArdle (1977) found less use by sharp-tailed grouse in burned areas compared to other vegetative manipulations, whereas Oedekoven (1985) suggested that prescribed burning in dense stands of sagebrush may be beneficial to Columbian sharp-tailed grouse. Fire results in vigorous sprouting of broom snakeweed (*Gu-*

tierrezia sarothrae) and rabbitbrush (*Chrysothamnus* spp.) (Blaisdell et al. 1982) that are of limited value to Columbian sharp-tailed grouse. Modern fire control policies have allowed conifers to invade bunchgrass-prairie habitats in some areas, to the detriment of Columbian sharp-tailed grouse populations (M. A. Wood, Mont. Dep. Fish, Wildl. and Parks, Kalispell, pers. commun., 1991); in these situations prescribed burning may be effective in maintaining suitable habitats.

Mechanical Treatments

McArdle (1977) concluded that chaining was the most beneficial habitat treatment for sharp-tailed grouse in the Curlew Valley of Idaho. Grouse responded almost immediately, and although mechanical treatments cost more than chemical treatments or fire, it was possible to control the amount of brush removed, shape of the treated area, and time of treatment. Livestock grazing on chained areas apparently limited dominance of grass and resulted in recovery of shrubs. No data are available concerning the effects of plowing or rotomowing on Columbian sharp-tailed grouse habitat, although both could be detrimental if they caused shrub and forb cover to decline.

RECOMMENDED GUIDELINES

The following guidelines reflect the current state of our knowledge of Columbian sharp-tailed grouse population ecology and habitat requirements; we recommend that all management activities that alter or impact habitats occupied by Columbian sharp-tailed grouse be documented and their effects on sharp-tailed grouse populations be closely monitored. Because there is a general lack of experimental data on the effects of habitat alterations on populations of Columbian sharp-tailed grouse, these guidelines represent hypotheses to be tested, and new information could result in the guidelines being modified.

Lek densities provide an index to sharp-tailed grouse populations (Cannon and Knopf 1981) and indirectly reflect changes in habitat quality. Leks also are more easily located and mapped than nesting, brood rearing, or winter habitats. Thus, wildlife agencies should monitor and maintain records of locations of Columbian sharp-tailed grouse lek sites (leks inactive for 5 consecutive years can be deleted, as they may reflect temporary leks or indicate extirpated populations) and make maps of these locations available to all land management agencies for use in environmental evaluations of proposed management activities.

The breeding complex (lek and nesting areas) includes all lands within a 2-km radius of lek sites, because most nesting occurs within this area. Because of the importance of these areas for nesting and brood rearing and the relative scarcity of Columbian sharp-tailed grouse, vegetation manipulation within this area should be avoided. If vegetation manipulation must occur, then it should be deferred until grouse population levels are ascertained and a comprehensive management plan has been formulated for the area. All impacts to affected Columbian sharp-tailed grouse populations, including lek attendance and nesting success, should be carefully monitored for possible mitigation.

Management Practices for Breeding Complexes

If disturbance to the breeding complex is unavoidable, disturbance activities should be restricted as follows:

1. Prohibit physical, mechanical, and audible disturbances within the breeding complex during the breeding season (Mar–Jun), if they might impact courtship activities and breeding during the daily display period (within 3 hr of sunrise and sunset).
2. Avoid manipulation or alteration of vegetation within the breeding complex during the nesting period (May–Jun). Management practices should not reduce height, canopy

cover, or density of chokecherry, snowberry, sagebrush, serviceberry, or other shrub species locally important for nesting. In bunchgrass-prairie communities, adequate height-density (Robel pole $\bar{x}$ = 2.5 dm) of residual grasses should be maintained for nesting.

Management Practices Within Occupied Columbian Sharp-tailed Grouse Habitat

1. No vegetation manipulation or disturbance that results in loss of deciduous tree and shrub height, canopy cover, and density should occur within 100 m of streams, including seasonally dry and intermittent secondary drainages. Cottonwoods (*Populus* spp.), willows, and deciduous shrubs in riparian areas should be protected and maintained. Livestock use of riparian areas should be managed or eliminated to minimize destruction of associated shrubs and trees.
2. Manipulation or disturbance of vegetation, including herbicide application, burning, or mechanical destruction that results in long-term (i.e., >5 yr) or permanent reduction of height, canopy cover, or density of mountain shrub habitats within occupied ranges should be avoided if shrubs comprise <10% of the cover within occupied areas. Management practices to rejuvenate or increase mountain shrub communities within breeding complexes or winter ranges should be restricted to ≤25% of this cover type annually.

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PROTECTION OF WILDLIFE RESOURCES

1201. IDENTIFICATION OF WILDLIFE SPECIES AND HABITATS

Prior to the preparation of a Comprehensive Drilling Plan or the submittal of a Form 2A for a proposed new oil and gas location, an operator shall review the Sensitive Wildlife Habitat map and the Restricted Surface Occupancy map maintained by the Commission on its website and attached as Appendices VII and VIII to determine whether the proposed oil and gas location falls within Sensitive Wildlife Habitat or a Restricted Surface Occupancy area. The operator shall include this determination in the Form 2A or Comprehensive Drilling Plan.

1202. CONSULTATION

a. The purpose of consultation under Rule 306.c is to allow the Director to determine whether conditions of approval are necessary to minimize adverse impacts from the proposed oil and gas operations in the identified sensitive wildlife habitat or restricted surface occupancy area, in an order increasing well density, or in a basin-wide order involving wildlife resource issues and to evaluate requests for variances from the provisions of the 1200-Series Rules. For purposes of this rule, minimize adverse impacts shall mean wherever reasonably practicable, to (i) avoid adverse impacts from oil and gas operations on wildlife resources, (ii) minimize the extent and severity of those impacts that cannot be avoided, (iii) mitigate the effects of unavoidable remaining impacts, and (iv) take into consideration cost-effectiveness and technical feasibility with regard to actions taken and decisions made to minimize adverse impacts to wildlife resources, consistent with the other provisions of the Act.

b. Unless excepted as set forth in Rule 1202.d, when a proposed new oil and gas location is located in sensitive wildlife habitat or a restricted surface occupancy area, the Colorado Division of Wildlife shall consult with the operator, the surface owner, and the Director in accordance with Rule 306.c prior to approval of a Form 2A to identify possible conditions of approval.

c. Any conditions of approval resulting from such consultation shall be guided by the list of Best Management Practices for Wildlife Resources maintained on the Commission website. In selecting conditions of approval from such Best Management Practices or other sources, the Director shall consider the following factors, among other considerations:

(1) The Best Management Practices for the producing geologic basin in which the oil and gas location is situated;

(2) Site-specific and species-specific factors of the proposed new oil and gas location;

(3) Anticipated direct and indirect effects of the proposed oil and gas location on wildlife resources;

(4) The extent to which conditions of approval will promote the use of existing facilities and reduction of new surface disturbance;

(5) The extent to which legally accessible, technologically feasible, and economically practicable alternative sites exist for the proposed new oil and gas location;

(6) The extent to which the proposed oil and gas operations will use technology and practices which are protective of the environment and wildlife resources;

(7) The extent to which the proposed oil and gas location minimizes surface disturbance and habitat fragmentation;

(8) The extent to which the proposed oil and gas location is within land used for residential, industrial, commercial, agricultural, or other purposes, and the existing disturbance associated with such use; and

(9) Permit conditions, lease terms, and surface use agreements that predate December 11, 2008.

d. Consultation under Rule 306.c shall not be required if:

(1) The Director or Commission has previously approved a Form 2A or Comprehensive Drilling Plan which includes the proposed new oil and gas location;

(2) The Colorado Division of Wildlife has previously approved, in writing, a wildlife mitigation plan or other wildlife protection or conservation plan that remains in effect for the area that includes the proposed new oil and gas location and the oil and gas location is in compliance with such plan;

(3) The operator demonstrates that the identified habitat and/or species, where applicable, is not in fact present to support the identified species and use, such as where the proposed oil and gas location is located in a high density area, designated pursuant to Rule 603.b, or within an incorporated homeowners association or city or town limits;

(4) The proposed new well would involve a one-time increase in surface disturbance of one (1) acre or less per well site at or immediately adjacent to an existing well site;

(5) The operator applies for and obtains a Commission order pursuant to Rule 503 providing that there will not be more than three (3) well sites per section, with ground disturbing activity during the period from January 1 to March 31 (or other biologically appropriate alternative period up to ninety (90) consecutive days as determined by the Director for bighorn sheep winter range, elk production areas, bald or golden eagle nest or roost sites, columbian or plains sharp-tailed grouse production areas, greater or Gunnison sage grouse production areas, black-footed ferret release areas, or lesser prairie chicken production areas) limited to one (1) such well site, as determined by the Director. This exemption from consultation shall not apply to operations in occupied greater sage grouse sensitive wildlife habitat in Moffat, Routt, or Jackson Counties or in occupied Gunnison sage grouse sensitive wildlife habitat in Delta, Mesa, Gunnison, San Miguel, Dolores, or Montezuma Counties;

(6) The Director grants a variance pursuant to Rule 502.b; or

(7) The Colorado Division of Wildlife waives the consultation requirement.

e. No permit-specific condition of approval for wildlife habitat protection under this rule shall be imposed without surface owner consent, including any permit-specific conditions for wildlife habitat protection that modify, add to, or differ materially from the general operating requirements in Rules 1203 and 1204. If the surface owner fails to consent to any such permit-specific condition of approval, then the parties shall consult with the surface owner regarding alternative conditions of approval acceptable to the surface owner.

1203. GENERAL OPERATING REQUIREMENTS IN SENSITIVE WILDLIFE HABITAT AND RESTRICTED SURFACE OCCUPANCY AREAS

a. **General Operating Requirements.** Within sensitive wildlife habitat and restricted surface occupancy areas, operators shall comply with the operating requirements listed below.

(1) During pipeline construction for trenches that are left open for more than five (5) days and are greater than five (5) feet in width, install wildlife crossovers and escape ramps where the trench crosses well-defined game trails and at a minimum of one quarter (1/4) mile intervals where the trench parallels well-defined game trails.

(2) Inform and educate employees and contractors on wildlife conservation practices, including no harassment or feeding of wildlife.

(3) Consolidate new facilities to minimize impact to wildlife.

(4) Minimize rig mobilization and demobilization where practicable by completing or recompleting all wells from a given well pad before moving rigs to a new location.

(5) To the extent practicable, share and consolidate new corridors for pipeline rights-of-way and roads to minimize surface disturbance.

(6) Engineer new pipelines to reduce field fitting and reduce excessive right-of-way widths and reclamation.

(7) Use boring instead of trenching across perennial streams considered critical fish habitat.

(8) Treat waste water pits and any associated pit containing water that provides a medium for breeding mosquitoes with Bti (*Bacillus thuringiensis v. israelensis*) or take other effective action to control mosquito larvae that may spread West Nile Virus to wildlife, especially grouse.

(9) Use wildlife appropriate seed mixes wherever allowed by surface owners and regulatory agencies.

(10) Mow or brushhog vegetation where appropriate, leaving root structure intact, instead of scraping the surface, where allowed by the surface owner.

(11) Limit access to oil and gas access roads where approved by surface owners, surface managing agencies, or local government, as appropriate.

(12) Post speed limits and caution signs to the extent allowed by surface owners, Federal and state regulations, local government, and land use policies, as appropriate.

(13) Use wildlife-appropriate fencing where acceptable to the surface owner.

(14) Use topographic features and vegetative screening to create seclusion areas, where acceptable to the surface owner.

(15) Use remote monitoring of well production to the extent practicable.

(16) Reduce traffic associated with transporting drilling water and produced liquids through the use of pipelines, large tanks, or other measures where technically feasible and economically practicable.

b. **Exceptions.** If the operator believes that any of the foregoing operating requirements should be waived for any proposed oil and gas location, it shall so specify in a Form 2A for Director consideration.

1204. OTHER GENERAL OPERATING REQUIREMENTS

a. The operating requirements identified below shall apply in all areas.

(1) In black bear habitat west of Interstate 25 and on Raton Mesa east of Interstate 25, operators shall install and utilize bear-proof dumpsters and trash receptacles for food-related trash at all facilities that generate such trash.

(2) In designated Cutthroat Trout habitat, as identified on the Colorado Division of Wildlife Species Activity Mapping (SAM) system, operators shall disinfect water suction hoses and water transportation tanks withdrawing from or discharging into surface waters (other than contained pits) used previously in another river, lake, pond, or wetland and discard rinse water in an approved disposal facility. Disinfection practices shall be repeated after completing work or before moving to the next water body. Disinfection may be performed by removing mud and debris and then implementing one of the following practices:

A. Spray/soak equipment with a disinfectant solution capable of killing whirling disease spores; or

B. Spray/soak equipment with water greater than 140 degrees Fahrenheit for at least 10 minutes.

(3) To minimize adverse impacts to wildlife resources, plan new transportation networks and new oil and gas facilities to minimize surface disturbance and the number and length of oil and gas roads and utilize common roads, rights of way, and access points to the extent practicable, consistent with these rules, an operator's operational requirements, and any requirements imposed by federal and state land management agencies, local government regulations, and surface use agreements and other surface owner requirements, and taking into account cost effectiveness and technical feasibility.

(4) Establish new staging, refueling, and chemical storage areas outside of riparian zones and floodplains.

(5) Use minimum practical construction widths for new rights-of-way where pipelines cross riparian areas, streams, and critical habitats.

b. **Exceptions.** If the operator believes that any of the foregoing operating requirements should be waived for any proposed oil and gas location, it shall so specify in a Form 2A for Director consideration.

1205. REQUIREMENTS IN RESTRICTED SURFACE OCCUPANCY AREAS

a. Operators shall avoid Restricted Surface Occupancy areas to the maximum extent technically and economically feasible when planning and conducting new oil and gas development operations, except:

(1) When authorized following consultation under Rule 306.c.(3);

(2) When authorized by a Comprehensive Drilling Plan;

(3) Upon demonstration that the identified habitat is not in fact present;

(4) When specifically exempted by the Colorado Division of Wildlife; or

(5) In the event of situations posing a risk to public health, safety, welfare, or the environment.

b. As set forth in Rule 1205.a, new ground disturbing activities are to be avoided in Restricted Surface Occupancy areas, including construction, drilling and completion, non-emergency workovers, and pipeline installation activity, to minimize adverse impacts to wildlife resources. Production, routine maintenance, repairs and replacements, emergency operations, reclamation activities, or habitat improvements are not prohibited in Restricted Surface Occupancy areas. Notwithstanding the foregoing, non-emergency workovers, including uphole recompletions, may be performed with prior approval of the Director on a schedule that minimizes adverse impacts to the species for which the restricted surface occupancy area exists.

c. **Applicability.** The requirements of Rule 1205 are not applicable to Applications for Permit-to-Drill, Form 2, or Oil and Gas Location Assessments, Form 2A, which are approved prior to May 1, 2009 on federal land or April 1, 2009 on all other land. The requirements of Rule 1205 are also not applicable until January 1, 2010, for any proposed oil and gas location in a Restricted Surface Occupancy area where the operator has in good faith initiated and is diligently pursuing consultation on the proposed oil and gas location begun prior to May 1, 2009 on federal land or April 1, 2009 on all other land, pursuant to Rule 306.c or Rule 216.

Appendix II: Mitigation Strategies – Undergrounding of Transmission Lines
Mick Meader, Cascabel Working Group, May 16, 2010

Introduction

Undergrounding or burial of transmission lines has become a nearly universal public request when new projects are proposed, and most lines would be at least partly undergrounded if it were not for the greatly increased cost – up to 10 times or more per mile – and technical complexity of doing so. Although U.S. utilities have extensively undergrounded power lines with voltages less than 230 kV and seem comfortable with this, undergrounding lines that have voltages of 230 kV and higher (EHV lines) is still unusual. As voltage increases, the expense of undergrounding lines increases geometrically, and the added technical complexity makes utilities and transmission companies uneasy. Thus as voltage increases, transmission lines become ever more challenging economically and physically to underground.

Even so, when new right-of-way is difficult or impossible to acquire, social objections are extreme, and the project is truly needed, burying extra-high-voltage AC lines up to 500 kV for short to medium distances is feasible and is sometimes the only solution. For long-distance undergrounding, DC lines must be used because the charging current in AC lines increasingly consumes transmission capacity with distance, limiting their usable length (*Rosenquist*, 2009). Undergrounding of EHV lines is more extensively done in Europe and Asia.

Precedents for Undergrounding 500-kV Lines

The first 500-kV cable installation in the world was in the Grand Coulee Dam in the mid-70s and was used to connect transformers to transmission busses (*Baptist and Nitta*, 1969). Twenty kilometers (12.5 miles) of 525-kV self-contained oil-filled (SCOF) cable manufactured by Sumitomo Electric of Japan were installed in tunnels in the dam and connected to six generating units. The lines were cooled with pumps that circulated the oil within the surrounding pipe (*Wikipedia*, 2010). Because of the age of the cable (more than 30 years), the Bureau of Reclamation plans to replace them with overhead lines in the near future (*Bureau of Reclamation*, 2009). In addition, the Bureau of Reclamation operates two 500-kV underground AC circuits at the Grand Coulee Dam that are about 6,000 ft long (*Bureau of Reclamation*, 2002).

The first 500-kV AC land cable installation was for the Honshu-Shikoku Interconnecting Line in Japan in 1989 (*Ohki*, 1989; *Minemura and Maekawa*, 1990). The cable was again manufactured by Sumitomo Electric, and the cable type was insulated oil-filled polypropylene laminated paper (PPLP, a form of SCFF cable). Twenty-two kilometers (13.7 miles) of cable was installed, 14 km (8.7 miles) underground on land (direct burial) and 8 km (5 miles) in the undercarriage of bridges (ten bridges total), sandwiched between the overlying roadway and underlying intercity railway (Figure 1). The cable delivers 1,200 MW of power, and no forced cooling is required because of the cable's construction. This is the same type of cable used in Singapore's 65-km (40-mile) underground 400-kV transmission system, which was installed about 10 years later (*Tsuruga et al*., 1999; see later discussion). Sumitomo Electric also supplied much of that cable (*Sumitomo Electric*, 2000). This cable type apparently is giving way to XLPE cable and is likely to be discontinued (*CCI*, 2010a).

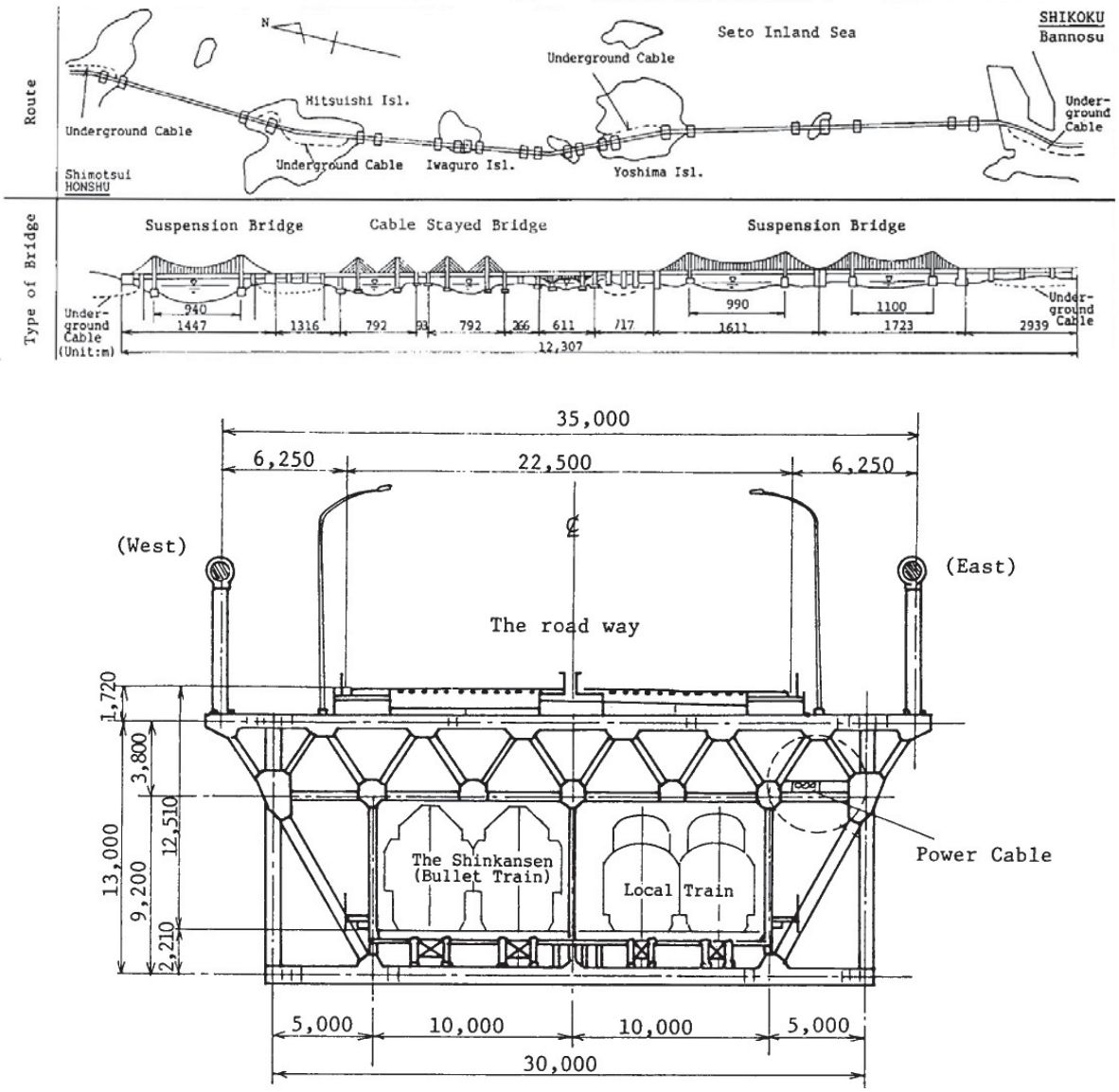

Figure 1. Top, map of islands and bridges that the Honshu-Shikoku Interconnecting 500-kV AC Line crosses. Bottom, cross section of one of the bridges showing the location of the power cable (from *Ohki*, 1989).

The two premier examples of more contemporary undergrounded 500-kV lines are in Tokyo (*George*, 2001; *CCI*, 2010b) and Shanghai (*Dubois*, 2007; *CCI*, 2010a), with a short distance in Russia. In Tokyo, two 40-km (25-mile) lengths were placed in a tunnel running into the heart of Toyko in 2000 (Figure 8, double-circuit line discussion, Appendix I), and two 17-km (10-mile) lengths are currently being installed beneath Shanghai (*CCI* ,2010b). Both of these were or are being installed in tunnels (Figure 2). Installation in tunnels helps to dissipate the heat generated by the lines, a major concern for underground EHV lines.

Figure 2. Left, 500-kV cables installed in tunnel in Tokyo. Right, installing 500-kV cable in tunnel in Shanghai (both from *CCI*, 2010b).

500-kV Underground Transmission Lines in the U.S. and Canada

The highest voltage for current underground projects in the United States is 345 kV (summarized in the next section), although underground 500-kV projects have been studied or proposed, the most extensive being for the Heartland Transmission Project in Edmonton, Alberta, Canada (*CCI*, 2010a, b). The Alberta Electric System Operator (AESO) is planning to construct a 65-km 500-kV double-circuit loop around the city of Edmonton, and stakeholders for the utility have requested that 10–20 km (6.2–12.4 miles) of the project be undergrounded. The proposed 500-kV system is composed of two transmission lines, each which would carry up to 1500 MW of power, an identical analog to the SunZia Project. The studies for undergrounding these lines are available at http://www.aeso.ca/transmission/20001.html. There is no more thorough or comprehensive reference on undergrounding 500-kV lines than this study. A map of the proposed project is shown in Figure 3, and a schematic of the burial scheme is shown in Figure 4.

Figure 3. Proposed underground double-circuit 500-kV transmission line for Edmonton, Alberta, Canada. (from *Altalink/Epcor*, 2010).

In addition, two other U.S. projects have considered undergrounding ~4-mile segments of single-circuit 500-kV projects. For the initial route proposed for its Sunrise Powerlink Project, San Diego Gas and Light was voluntarily going to underground two ~4-mile segments in critically sensitive areas (*SDGE*, ~2007). In addition, Southern California Edison is retaining the option to underground a 4-mile

segment of its 500-kV Antelope-Pardee line at the request of the U.S. Forest service (*Aspen Environmental Group*, 2006).

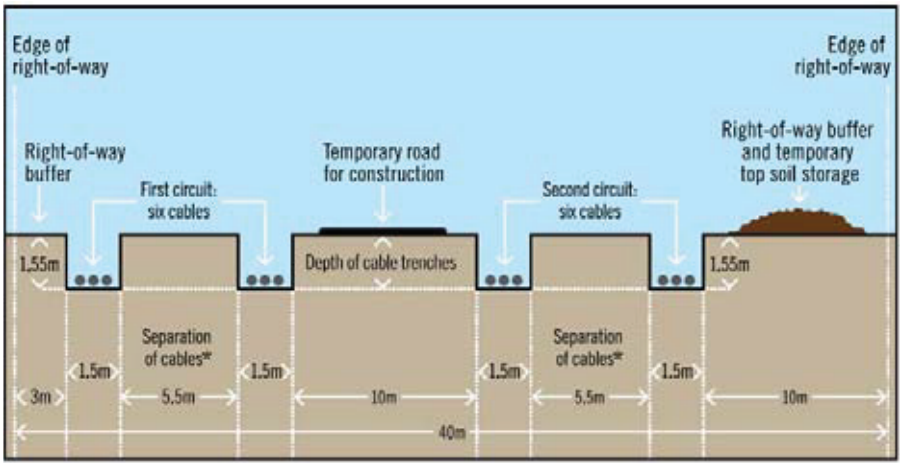

Figure 4. Burial scheme for both circuits of the 500-kV Heartland Transmission Project (from *Altalink/Epcor*, 2010). Note that the width of right-of-way required for burial is 40 m (131 feet), a major consideration. Placing the lines in ducts or a tunnel would reduce the width required. Note also that each overhead circuit is divided between two underground sets of cables.

U.S. Examples of Undergrounded 345-kV Lines

In the U.S., no 500-kV lines have been undergrounded, although several 345-kV lines have been. Table 1 summarizes these.

Table 1. U.S. 345-kV Underground Cable Projects.

City/State	Project	Cable Type	Circuits x Miles	Mode	Year
Boston	NSTAR	HPFF	2 x 17 1 x 13	conduit	2007
Chicago	Crawford-West Loop	XLPE	2 x 10	conduit and tunnel	2008
Chicago	General	XLPE	2 x 5	conduit	2008
Connecticut	Bethel-Norwalk	XLPE	1 x 24	direct buried/ducts	2008
Connecticut	Middleton-Norwalk	XLPE	1 x 2.1	direct buried/ducts	2006
Detroit	Bismark-Troy	XLPE	1 x 11	ducts	2010
Detroit	Goodison	XLPE	1 x 8.1	unknown	2009
Houston	Power plant connect	XLPE	1 x 0.9	ducts	2004
Minnesota	CapX2020	XLPE/ HPFF	2 x 2	PVC conduit/cable pipe	being studied
New York	Yonkers-Manhattan	FF	1 x 9.3	ducts	2008-10
New York	Neptune/Long Island	XLPE	1 x 2.5	unknown	2007
New York	Newbridge Road	XLPE	1 x 13	unknown	being studied
Pittsburgh	Brady Project	HPFF?	1 x 6.4 1 x 2.1	conduit?	2012?

The two most notable projects are Connecticut Light and Power's Bethel–Norwalk line, which is 24 miles long, and NSTAR's Transmission Reliability Project into downtown Boston, which is composed of two 17-mile-long lines and one 13-mile-long line. NSTAR used an HPFF system (high-pressure fluid-filled), and each line was placed in an 8"-diameter conduit, which was filled with dielectric oil to insulate the lines and dissipate heat. This design allowed all three circuits to be placed in the same 4-ft-wide trench. HPFF cable technology was chosen over XLPE for this very reason – it allowed a much closer spacing of the lines, significantly reducing the required width of the trench. Figure 5 illustrates installation of the cable (after conduit has been laid).

Figure 5. Installation of the three cables of a single circuit in NSTAR's 345-kV Boston underground transmission project. Underground conduit has already been installed (from http://www.transmissionproject.net/PhotoGallery.asp).

Worldwide Underground Extra-High-Voltage Cable Installations

The undergrounding of EHV lines is more prevalent in Europe and parts of Asia because these areas are more densely settled and it is difficult if not impossible to place the lines above ground in certain areas. Tokyo is the premier example of this. Table 2 (from *Europacable*, 2009) lists major 400-kV underground projects in Europe. Note that the majority of these lines are double-circuit lines. Table 3 shows high-voltage and extra-high voltage underground projects worldwide as of 2009 (the list is incomplete).

Table 2. Examples of major 400-kV underground projects in Europe (from *DelBrenna*, 2009).

Location	Project	Circuits x Length (km)	Cables per Phase	Time Period
Copenhagen	Elimination of overhead lines in urban area	1 x 22,1 x 12	1	1996 1999
Berlin	Connect West/East system	2 x 6;2 x 6	1	1998 2000
Vale of York	Area of outstanding beauty	4 x 6	2	2000/1
Madrid	Barajas Airport Expansion	2 x 13	1	2002/3
Jutland	Area of outstanding beauty, waterway and semi urban areas	2 x 14	1	2002/3
London	London Ring	1 x 20	1	2002/5
Rotterdam	Randstad waterway crossings	2 x 2.1	1	2004/5
Vienna	Provide power to centre of city	2 x 5.5	1	2004/5
Milan	Section of Turbigo-Rho line	2 x 8.5	2	2005/6
Switzerland/ Italy	Mendrisio – Cagno	1 x 8	1	2007/8

Table 3

Europacable

Overview of EHV Land AC cable installations August 2009

Location	Project	Length system (km)	Route length (km)	Type of cable Cu/Al	XLPE/FF	Voltage	Size mm²	Construction	Time period
Dachaoshan Power Plant, China	Connect power plant to grid	7,2	1,2	Cu	XLPE	525	800		2001
Shibo-Shanlin, Shanghai, China	Connect 2 substations	51	17	Cu	XLPE	500	2500	To be laid in tunnel	2007-2009
Shinkeiyo, Tokyo, Japan	Connect 2 substations	240	40	Cu	XLPE	500	2500	Laid in tunnel	2000
Ertan Hydro Station, China	Connect power plant to grid	8,2	3	Cu	XLPE	500	800	Direct burial	1996
Shoaiba, Saudi Arabia	Connect power plant to grid	34	6,4	Cu	XLPE	420	800	Direct burial	2001
Koyna Hydro, India	Connect power plant to grid	6,5	1,1	Cu	XLPE	420	800	Direct burial	1997
Copenhagen - North	Elimination of OHLs in urban areas	37	12	Cu	XLPE	420	1600	Direct burial 1.5m below ground in a 1.1m wide trench	1998-1999
Copenhagen - South	Elimination of OHLs in urban areas	67	22	Cu	XLPE	420	1600	Direct burial 1.5m below ground in a 1.1m wide trench	1996-1997
Goldisthal Pump Storage (Ger)	Connect new power plant to grid	13	4,4	Cu	XLPE	420	630	Laid in pipes and tunnel	2003-2004
London	London Ring	60	20	Cu	XLPE	400	2500	Ventilated tunnel 30 meters below ground	2002-2005
London	West Ham - Hackney	37	12,6	Cu	XLPE	400	2500	Ventilated tunnel	2008
Croydon (UK)	Beddington - Rowdown	30	10	Cu	XLPE	400		To be laid in tunnel	2008-2011
Berlin	Connect West/East systems	70	11,5	Cu	XLPE	400	1600	Ventilated tunnel 30 meters below ground	1996-2000
Aalborg (DK)	Avoid OHL in semi urban/rural area	45	7,5	Al	XLPE	400	1200	Direct burial of 6 cables in two 2m wide trenches	2003
Madrid Airport	Airport expansion	78	13	Cu	XLPE	400	2500	Ventilated tunnel under runway	2002-2003
Manchester Airport (UK)	Airport expansion	14	4,8	Cu	FF	400	2000	Direct burial 2m below ground (3 cables)	2004
Dartford Tunnel (UK)	Replace cables in a road tunnel	15	2,6	Cu	XLPE	400		Cables laid in newly constructed tunnel	2004-2005
Woodhead Tunnel (UK)	Replace cables in old railway tunnel	15	5	Cu	XLPE	400		Cables laid in tunnel	2008-10
Mariager Fjord (DK)	Waterway crossing	15	2,5	Al	XLPE	400	1200	Laid in plastic pipes 1.5m below river in two 2 m trenches	2003
Vale of York (UK)	Area of Outstanding Beauty	72	5,7	Cu	FF	400	2000	Direct burial	2000-2001
Gudena Valley (DK)	Area of Outstanding Beauty	27	4,5	Al	XLPE	400	1200	Direct burial of 6 cables in two 2m wide trenches	2003
Naples	Teverola power plant	3,6	1,2	Al	XLPE	400	1200	Direct burial	2005
Staythorpe Power Station (UK)	Connect power plant to grid	18,6	3,1	Cu	XLPE	400	1000	Direct burial	2000
Taweelah Power Station, Abu Dhabi	Connect power plant to grid	15,7	1,2	Cu	XLPE	400	800	Ducted	2000
Shuweihat Power Station, Abu Dhabi	Connect power plant to grid	27	4,5	Cu	XLPE	400	630		2004
Umm al Nar, Abu Dhabi	Connect power plant to grid	27	4,5	Cu	XLPE	400	800		2004-2005
Abu Dhabi	Connect 2 substations	76	8,5	Cu	XLPE	400	2500		2003-2006
Great Belt - Denmark	Connect East/West systems	18	6	Cu	XLPE	400		32km cable (6km on land)	2010-12
Milan	Turbigo - Rho line	51	8,4	Cu	XLPE	380	2000	Buried in trench	2005-2006
Switzerland - Italy	Mendrisio-Cagno	27	9	Cu	XLPE	380		Direct burial, 1st merchant line in Europe	2007
Vienna	Provide power to central area of city	33	6	Cu	XLPE	380	1200	Direct burial 2.7m below ground - water cooling installed	2004-2005
Nieuwe Waterweg/Calandkanaal (NL)	Waterway crossings	13	2,3	Cu	XLPE	380	1600	Cables laid below waterway by directional drilling	2004-2005
Rotterdam (NL)	Connect new power plant to grid	37	6	Cu	XLPE	380			2009-10
Frankfurt (Ger)	Connect new power plant to grid	8,4	2	Cu	XLPE	380			2009-10
Faisalayah/Jedda, Saudi Arabia	Connect 2 substations	27	4,5	Cu	XLPE	380	2500		2004-2005
Al Jamia, Saudi Arabia	Connect power plant to grid	33,6	5,6	Cu	XLPE	380	2500		2001
Mantova (It)	Connect Enipower plant to grid	8	2,7	Cu	XLPE	380	1200	Direct burial	2004
Mantova (It)	Connect Enipower plant to grid	16	5,4	Cu	XLPE	380	1600	Direct burial	2004
Piacenza (It)	Connect power plant to grid	2,4	0,8	Cu	XLPE	380	800		2005
Total 380-525kV		1384,2	288,5						
Taichung Power Station, Taiwan	Connect power plant to grid	60	2,6	Cu	XLPE	345	2000		2003
Pusan, South Korea	Nampusan - Bukpusan	66	22	Cu	PPL	345	2000	Tunnel	1998-2003
Seoul, South Korea	Mikeum - Soungdong	50	16,7	Cu	PPL	345	2000	Tunnel	1997-2002
Seoul, South Korea	Shinyangjai - Shinsoungnam	54	9	Cu	PPL	345	2000	Tunnel	2001
Seoul, South Korea	Youngseo - Youngdeungpo	59	9,8	Cu	XLPE	345	2000	Tunnel	2003
Connecticut, USA	Bethel-Plumtree	42	7	Cu	FF	345	1590	Direct buried, ducts	2005-2006
Connecticut, USA	Plumtree-Hoyts Hill	12	2	Cu	XLPE	345	1590	Direct buried, ducts	2005-2006
Connecticut, USA	Milford-Bridgeport	80	40	Cu	XLPE	345	1590	Direct buried, ducts	2006-2008
Boston, USA	K Street	12	1	Cu	XLPE	345	1400		2006
Houston, USA	Connect power plant to grid	22	1,5	Cu	XLPE	345	630	Ducts	2004
Detroit, USA	Goodison	39	13	Cu	XLPE	345			2008-2009
Detroit, USA	Bismark - Troy	54	18	Cu	XLPE	345		Ducts	2009-2010
New York (USA)	Yonkers - Manhattan	45	15	Cu	FF	345		Ducts	2008-2010
Sydney, Australia	Sydney South - South Central	84	28	Cu	PPL	330	1600	Direct buried, ducts, tunnels	2004
Glasgow, Scotland	Busby- Giffnock	33	11,2	Cu	FF	275	500	Unfilled ducts	2006
Liverpool, England	Kirkdy-Lister Drive replacement	33	11	Cu	XLPE	275		Trench	2007-2010
Chiba, Japan		48	16	Cu	XLPE	275	800		1997-2000
Kawasaki, Japan	Kawagoe-Nishinagoya	86	14,4	Cu	XLPE	275	2500	Tunnel	2002
Creux de Chippis, Switzerland	Connect power plant to grid	24	2	Cu	XLPE	275	1200		1997
Stockholm	Provide power to district heating plant	2,4	0,8	Al	XLPE	245	630	Part burial in ground & part laid in 630m tunnel	1985
Langa Hydro Power Plant (Swe)	Replacement of aging cables	5	1,6	Al	XLPE	245	1200	In a 220m vertical shaft	1991
San Roque, Spain		10,7	3	Cu	XLPE	245	2000		2000
Ofima, Switzerland		17,5	3	Cu	XLPE	245	500		2000
Al Jubail, Saudi Arabia	Connect power plant to grid	5,4	1,8	Cu	XLPE	245	1000		1998
Buenos Aires, Argentina	Urban area	22,3	7,5	Cu	XLPE	245	630		1998
Guandong, China	Replace OHL in urban area	24	8	Cu	XLPE	245	1000	Part burial in ground & part laid in tunnel	2000
Total 245-345kV		990,3	265,9						
San Jose, Califonia	Jefferson-Martin link	56,9	19	Cu	XLPE	230	1267	Ducts, direct buried	2002
Santa Clara, California		25,6	8	Cu	XLPE	230	1267		2004
Nevada Power (US)	Connect power plant to grid	23	8	Cu	XLPE	230	2500		2002-2003
PG&E, Tri Valley (US)		67,4	22	Cu	XLPE	230	1000		2003
Truca Van Nuys, California		33	11	Cu	XLPE	230	1000		2003
Baltimore (US)		25	8	Cu	XLPE	230	2000		2003
Newark, New Jersey (US)	Essex - Aldene	90	30	Cu	XLPE	230			2006-2007
Paris	Avenir-Sausset	54	18	Cu	XLPE	225	1200	Duct bank, trough & tunnel	2001-2002
Cote D'Azur (F) -Antibes - Mougins	Rural/tourist area	68	11,3	Cu	HDPE	225	1200	Duct bank	1997
Biancon - Mougins, France	Rural/tourist area	25	8,3	Cu	XLPE	225	1600	Duct bank, trough & tunnel	2002
Biancon - Plan de Grasse	Rural/tourist area	22	7,4	Cu	XLPE	225	1600	Duct bank, trough & tunnel	2002
Dunkirk Power Plant, France	Connect new CCGT plant to grid	55	18,5	Cu	XLPE	225	2000		2004
Le Havre Power Plant, France	Connect cogen plant to grid	14	4,8	Cu	XLPE	225	1200		2003
Nimes, France	Nimes-Talabot link	14	4,6	Cu	XLPE	225	1200	Duct bank, trough & tunnel	2001
Paris (Seine-Maritime)	Pont 7 - Sainneville	13	4,4	Al	XLPE	225	800	Duct bank & trough	2002
Guadalajara, Mexico	Aqua Azul - Alamo	30	5	Cu	XLPE	225	1000	Duct	2002
Tunis, Tunisia	Rades - Gromnalia 2	148	24,7	Cu	XLPE	225	1000	Duct	2005
Valencia,Spain	Patraix-F.San Luis	19	6,4	Cu	XLPE	220			2006
Lisbon	Alto Mira	19,7	6,5	Cu	XLPE	220	1200	Direct burial	2003
Lisbon	Carriche - Sete Rios	22	7,6	Cu	XLPE	220	1240	Direct burial	1998-1999
Dublin	Shellybanks	42	14	Cu	XLPE	220	1600	Direct burial, river crossing	1997
Dublin	Irishtown - Inchicore link	33	11	Cu	XLPE	220	1600	Cables laid in trench	2001-2002
Milan	Pioltello	18	6	Al	XLPE	220	1600	Direct burial	2005
Barcelona Waterfront	Besos-Mata & Vilanova	34	11,5	Cu	XLPE	220	1000	Direct burial	2003-2005
Montorio Power Plant (It)	Replacement of aging cables	3	0,9	Cu	XLPE	220	300	In a 240m vertical shaft	2000
Lubeck, Germany	Lubeck-Siems link of Baltic cable	61	10,2	Cu	XLPE	220	1200	Pipes, direct buried, 1.2m in rural areas	2004
San Bernabe, Mexico		75	25	Cu	XLPE	220	1600		2001
Kansai, Japan		12	4	Cu	XLPE	220	2500	Direct burial	2005
Oman, Sohar	Connect power plant to grid	10	3,3	Cu	XLPE	220	2500	Direct burial	2005
Bahrain	Replacement of FF cables	600	100	Cu	XLPE	220	1400	Direct burial	2000
Vietnam	HoChiMinh City	37	6,2	Cu	XLPE	220	1600	Direct burial	2002
Total 220-230kV		1749,6	425,6						
Total 220-525kV		4124,1	980						

Some of the more notable projects are the London ring, which, when completed, will include 40 km (25 miles) of underground 400-kV cable with an additional 10.7 km (6.6 miles) planned for the future (Figures 6 and 7; *National Grid*, ~2008). Copenhagen direct-buried its two 400-kV trunk lines in the late 1990s (*Christensen and Roes*, 2001), and Madrid undergrounded its 13-km (8-mile) double-circuit 400-kV lines around the Barajas Airport in 2005 (*Granadino*, 2005). One notable underground 400-kV system that is missing from Table 3 is that of Singapore (Figure 8; *Chang et al*., 2001), which has a total underground 400-kV cable length of ~65 km (40 miles). This system used PPLP-insulated oil-filled cables laid in concrete-reinforced trenches (*Tsuruga et al*., 1999) rather than XLPE cables, which were just being developed at this time for extra-high voltages.

Figure 6. London cable tunnel for 400-kV line. The tunnel is built large enough to accommodate a second 400-kV line in the future. (From *National Grid*, ~2008.)

Figure 7. Map of London cable tunnels (from *National Grid*, ~2008). Total length of tunnels currently under construction is ~40 km (25 miles), with another 10.7 km (6.6 miles) planned.

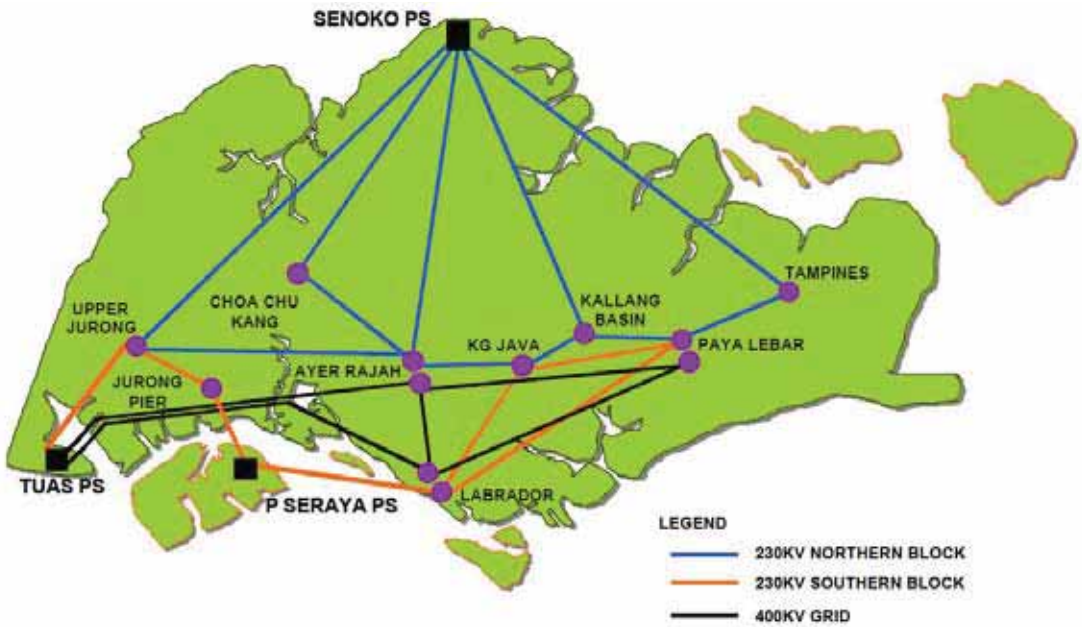

Figure 8. Singapore 400/230 kV underground transmission system (from *Chang et al*., 2001). Total length of underground 400-kV cable is ~65 km (40 miles).

Types of Underground Cables

There are four basic types of underground cables that are current used, and the following briefly describes these. These are summarized in many publications, including the Wilderness Society's initial report on the SunZia Project (*The Wilderness Society*, 2009), but a summary is included here for easy reference. Each has its advantages and disadvantages, especially with regard to undergrounding techniques. Superconducting technology exists as well but is not discussed here because it is not sufficiently developed to use (*CCI*, 2010b). Most of the following discussion is taken from *PSC Wisconsin* (2006).

HPFF – *High-pressure fluid filled*. The three cables of a single AC circuit are placed in conduit, and then the conduit is filled with dielectric oil to both insulate the lines and dissipate heat. This type of installation can require pressure stations along the route, and pumps may need to be used to circulate the oil to dissipate heat. In the past, this type of installation has been the most commonly used in the U.S. and is the most trusted by U.S. utilities. Because all three cables can fit closely together in a single conduit, this greatly reduces the width of trench required for the cables. In the Boston NSTAR 345-kV example cited earlier, a single 8" conduit can contain all three cables for a line, and several circuits can be placed together in a 4-foot wide trench. One drawback with this cable time is that the conduit can leak oil into the environment if damaged.

HPGF or GIL – *High-pressure gas-filled or gas insulated*. This installation type is very similar to HPFF except that pressurized nitrogen insulates the cables rather than dielectric fluid. Nitrogen is less effective as an insulator and coolant than dielectric fluids (usually oil), however.

SCFF – *Self-contained fluid filled*. In this type of cable, the dielectric insulating oil is incorporated into the interior of the cable itself, and conduit is not needed. All three cables are independent and are run in separate ducts or buried separately. As with HPFF cable, if damaged,

the insulating oil can contaminate the environment. The lines are insulated with kraft paper and are protected by an aluminum sheath and plastic jacket. A variation of this is the PPLP, or polypropylene laminated-paper cable. In this case, the insulating jacket is a sheet of polypropylene placed between sheets of kraft paper. This cable type was used for Singapore's 400-kV underground transmission system.

XLPE – *Crosslinked polyethylene*. Often referred to as "solid dielectric," this cable type is fast becoming the standard for underground transmission lines, replacing HPFF and SCFF. It contains no fluid or gas for insulation, making it easier to use and maintain. Should it fail, it thus has less environmental repercussions than HPFF and SCFF cable. Preventing contamination of the polyethylene insulation is critical to prevent electrical discharges and breakdown of the line from electrical stress. The insulation is also about twice the thickness of that for oil-insulated cables. A circuit using XLPE cable has three cables, one for each phase, which are buried separately or inserted into individual ducts.

Installation Types

There are five basic modes of burying cable: (1) direct burial (XLPE, SCFF), (2) duct bank (XLPE, SCFF), (3) vaults or troughs (XLPE, SCFF), (4) conduit (HPFF, HPGF), and (5) tunnel (XLPE, SCFF).

Direct Burial

Direct burial of lines requires the greatest width of ground and appears most suited to open country, agricultural land in particular. Once buried in this setting, the land above the cables can be reused for planting, and any apparent scarring of the land from trenching disappears. If directly buried, a single 500-kV line would require a strip of land approximately 80 feet wide to be cleared of vegetation (*Aspen Environmental Group*, 2006). With an additional line, this width of ground can be up to 130 feet wide (*CCI*, 2010b). With time, and depending on setting, much of the ground disturbance will heal.

When overhead lines are undergrounded, it at times requires more cables to carry the equivalent amount of power to distribute the heat generated by the lines (Figure 9), broadening the width of area required for burial. An example of a trench used for burying a 400-kV line is shown in Figure 10. One difficulty with this method in an urban setting is that a trench must be opened that is as long as the cable available from a single reel, which can be up to 700 m (2300 feet) long (*CCI*, 2010a). Using ducts eliminates this need, although doing so is more time consuming and expensive.

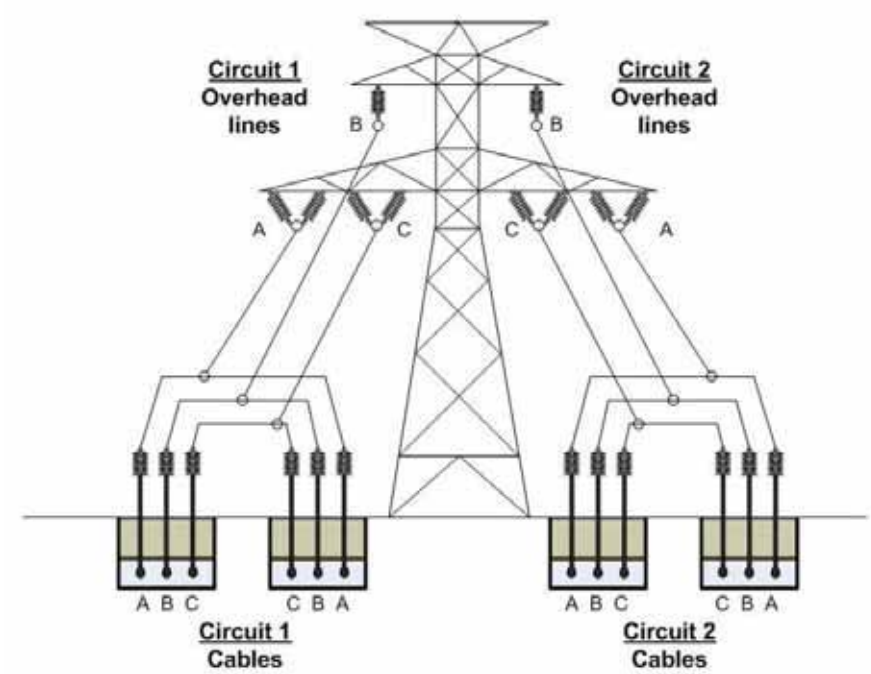

Figure 9. Transition from overhead 500-kV double-circuit transmission line to underground segment proposed for the Heartland Project, Alberta (from *CCI*, 2010b).

Figure 10. Direct-burial trench for one circuit of a 400-kV AC line. The number of trenches depends on how many conductors are required to carry a single circuit. Two trenches are often required, as more conductors are at times needed to carry the same amount of power because of the need to dissipate heat. For the Alberta double-circuit line, four trenches are required to bury the two 500-kV circuits. Because of the need for vehicle access, the width of the disturbed area for underground burial is far wider than the actual trench width. This is the least expensive form of undergrounding. (From *Highland Council*, 2005.)

Ducts and Vaults

The use of ducts (Figure 11) allows a tighter arrangement of cables and can reduce the width of the trench area. Vaults need to be installed approximately every 2000 feet for installation, splicing of cable, and servicing. Ducts also leave the individual cables free so that they can be easily removed for servicing. Additional ducts are at times installed for back-up cables to increase reliability, and directional drilling is at times to use to install ducts beneath areas that are inaccessible by trenching. In direct burial, trenches are at times lined with concrete to create underground vaults to carry the cables (Figure 12).

Figure 11. Installation of cables in ducts. This allows lines to be stacked vertically, and this strategy is often used in urban settings. This technique can be used for either XLPE or SCFF cable. (From *San Diego County*, 2010.)

Figure 12 Installation of 230-kV circuit in concrete-lined trench/vault, New Zealand. The photo on the right appears to show conduit, with the cable inside and all three phases [cables] bundled together. The sides of the trench would also indicate that this is direct burial of the line. (From *Transpower*, 2010.)

Conduit

The use of high-pressure fluid-filled conduit for cable installation (HPFF, Figure 13) greatly condenses the space required for underground lines (an entire circuit for a 345-kV line can be placed within an 8" diameter conduit), but this is also more expensive, and the conduit must be filled with dielectric oil for insulation and heat dissipation. If the conduit were breached, this would leak oil into the surrounding ground and contaminate it. Stations that maintain oil pressure are also required, and the oil may need to be circulated to cool the lines.

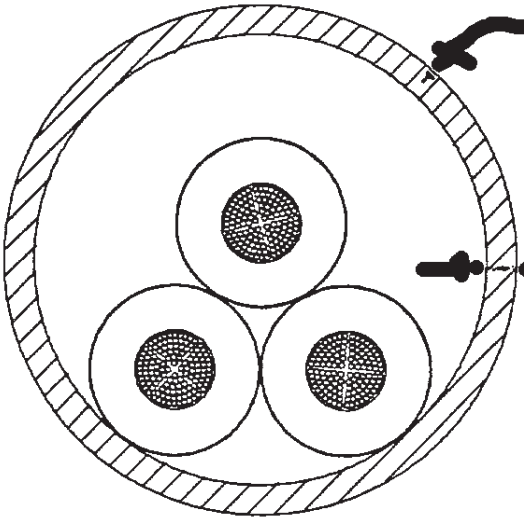

Figure 13. Cross section of a high-pressure fluid or gas-filled conduit used with HPFF or HPGF (GIL) cables. This conduit is filled with dielectric oil for insulation and cooling, and this arrangement allows the most compact arrangement of cables. The cost of such systems is increased because stations must be installed to maintain oil pressure and, if needed, to circulate the oil for cooling purposes. (See Figure 5 for an illustration of how cables are installed in conduit.) (From *PSC Wisconsin*, 2009.)

Tunnels

The ultimate solution to undergrounding extra-high-voltage lines is to bore a tunnel (Figure 14), which has been done in several large cities, including Tokyo, Shanghai, London, and Madrid. ConEd also bored a tunnel beneath the Chicago River for its 345-kV underground project. The cost of tunneling greatly exceeds all other undergrounding methods. Ventilation and circulation of air in tunnels is also needed to reduce heat built-up (*CCI*, 2010a). Ampacity (current carrying capacity) must sometimes be limited to keep heat generation below a specific level, possibly limiting the power a circuit can carry.

Figure 14. The ultimate solution for underground lines – the tunnel. By far the most expensive option, tunnels provide the greatest ease of access and maintenance, and air-circulation equipment can be added to maintain cooling of the lines. Tunnels can also be sized to allow for the addition of additional lines later at less cost and time. The is ComEd's 300' tunnel beneath the Chicago River for its 345-kV underground line, installed in 2008. (From *Donnelly*, 2008).

Other Considerations

Another consideration for underground lines in urban settings is the need for joint bays to splice the cable at specific intervals and for manholes to service the lines. This increases the complexity and cost of installation. Testing of the underground portion of a 500-kV project would also delay the in-service date by 1-2 years (*CCI*, 2010b). The cost of undergrounding

high-voltage lines increases exponentially with voltage (the relationship is not linear), which quickly diminishes the economic feasibility of burying longer lengths of line.

Costs for the underground portion of the Heartland 500-kV project are shown below for two scenarios. The cost of burying the entire 40-mile length of the Heartland Project (~ $1.5 billion) would approach that of the entire SunZia Project as it is currently configured, and simply acquiring the amount of cable needed would pose a significant difficulty (*CCI*, 2010b). Because of these two factors, burial of the SunZia lines could be done for only shorter distances.

Table 4. Estimated costs of burying different lengths of 500-kV line for the Heartland (four groups of cables installed at one time).

Underground Distance	Approximate Cost of Cable	Approximate Cost of Overhead–Underground Transition Stations	Total Estimated Cost
10 km (6.2 miles)	$237 Million	$80 Million	$317 Million
20 km (12.4 miles)	$443 Million	$106 Million	$549 Million

Addendum: Use of Interstate 10 Median for Undergrounding SunZia Lines

It is initially very appealing to consider using the median of I-10 to route the SunZia Southwest Transmission Project through Tucson, and such use of medians has been investigated by others. Routing the lines above ground in an Interstate median, per se, is legally forbidden in all states and presumably by the U.S. Department of Transportation (survey by *Connecticut Department of Transportation*, undated). This survey was apparently undertaken in response to inquires by Connecticut Light and Power (CLP) (Northeast Utilities System) and United Illuminating Company (ULC) into routing its 345-kV Middleton-Norwalk line in the median or right-of-way of Interstates 91 and 95 and U.S. Highway 7 in Connecticut.

In pursuit of this, CLP and ULC further commissioned a study to determine the feasibility of using the medians of these interstates for burying the line (*Burns and McDonnell*, 2003). Burns and McDonnell determined that a single-circuit 345-kV overhead line would require a right-of-way of 120’ and that an underground line would require 40’ (15’ permanent easement and 40’ of temporary easement). They then assessed the three routes mentioned above and found that only parts of them were feasible because of these constraints.

In Tucson, the critical area where burial of SunZia transmission lines might be needed is through the center of the city, and applying these criteria to the median of Interstate 10 shows that burying the lines here is not feasible. No median now exists from Park Avenue to the southeast to almost Prince Road to the north, a distance of ~6.85 miles. In addition, the median of I-10 appears too narrow to accommodate undergrounding at least to Ina Road, an additional 5.0 miles to the northwest.

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Underground High Voltage Cables: Wiring Europe for the Future

Underground High Voltage Cables: Wiring Europe for the Future

In many of Europe's largest cities and in areas where construction of overhead transmission lines creates difficulties, high and extra-high voltage underground electricity cable systems rated 220kV and above have become part of the backbone of modern day power transmission infrastructure. Although cables have been in use for over half a century, today's underground high voltage cables are leveraging state-of-the-art technology and advanced design to expand their reach and are increasingly becoming an efficient and reliable alternative to overhead lines. Underground high voltage cables are powering a changing world.

This eBook presents the main benefits of underground high voltage cables:

- Versatile and Unique
- Cost Effective Solution
- Enhanced Technology
- Increased Reliability
- Reduced Transmission Losses
- Advanced Installation Techniques
- Improved Monitoring

If you are a cable specialist and are interested in learning more details about underground high voltage cables, choose from the topics below:

- Environmental: Information about EMFs, land issues, recyclability, installation impacts, and sensitivity benefits.
- Regulation: Details on basic mechanisms, regulatory drivers, and incentives.
- Case Studies: Presentation of reliability showcases, unstopping bottlenecks, overcoming obstacles, and strategies for success.
- System Reliability: Information about overload capacity, failure issues, technical changes, and warranties and testing.
- Life Cycle: Details about transmission losses, planning delays, and replacement cycles.

Versatile and Unique

Underground cables have unique properties for transmitting power - they are out of sight, often require only a narrow band of land to install, emit no electric field and can be engineered to emit no magnetic fields, have better power loss characteristics and can absorb emergency power loads. As a result, underground cables assist the transmission of power across:

- Densely populated urban areas;
- Areas where land is unavailable or planning consent is difficult;
- Rivers and other natural obstacles;
- Land with outstanding natural or environmental heritage;
- Areas of significant or prestigious infrastructural development; and
- Land whose value must be maintained for future urban expansion and rural development.

Cost Effective Solution

In the past, the higher cost of underground cables was a significant deterrent to their use. However, with lower cost production methods, improved technologies and increased reliability, the cost differential between underground cables and overhead power lines is narrowing. This means that power project developers are more frequently turning to underground cables as an economic and technically effective alternative when physical obstructions or public opinion hinder the development of networks. Opportunity costs from lengthy planning delays are reduced and the expense and complexity of public legal cases are minimized.

Apart from the reduced visual impacts, underground cables also offer lower maintenance costs than overhead lines. They are also less susceptible to weather-related issues such as storm damage, interruptions, costs of storm damage surveys and precautionary storm shutdowns. In addition, underground cables contain high quantities of copper, the most conductive engineering metal, resulting in 30 percent lower power losses than overhead lines at high circuit loads and improved system efficiency.

Advanced Features Offer Savings and Reliability

Today's cable manufacturers are able to provide innovative and customized solutions for the modern state-of-the-art power transmission industry. Underground high and extra-high voltage cables are equipped with new design features, such as real-time monitoring, which make them an effective and reliable alternative to overhead lines.

Enhanced Technology

Cables for burial on land using extruded insulation technology are taking the place of traditional oil-filled cables because of significant advantages that include:

- Easier installation and jointing;
- Better environmental compatibility and friendliness in service;
- Reduced installation costs; and
- Reduced or practically zero maintenance.

Increased Reliability

Today's cable systems, using cross-linked polyethylene (XLPE) as the primary insulation material, have been performance tested to ensure reliability. New cables based on this technology have been running for over 20 years with an excellent reliability record.

Reduced Transmission Losses

Underground extra-high voltage cables generally have more efficient copper conductors and operate at lower temperatures than overhead lines. These properties combine to transmit energy to end users as efficiently as possible, which is especially important for remote renewable and low carbon generators. Reducing these power transmission losses makes a valuable contribution to lowering greenhouse gas emissions.

Advanced Installation Techniques

With new burial and jointing techniques, underground cable projects that once took years to complete can now take only months to install. Through the use of directional drilling and "trenchless" burial

techniques, cable manufacturers are applying leading edge design know-how to dramatically reduce installation times. In some installations, where it is not possible to trench or duct the cables, underground tunnels have been built to carry the cables. In some cases, significant cost savings have been made by placing cables in existing tunnel systems.

Improved Monitoring

To reduce outage time, power system operators can monitor underground cables through built-in temperature sensors. The sensors allow the cable to safely accept enormous emergency power overloads when other parts of the network are down. This means that the overall system becomes more robust and supply is maintained. In the rare event of a cable fault, generally caused by external disturbance, advanced monitoring of temperature and integrity in real time will allow faults to be located and repairs to be carried out in a much shorter timeframe than in the past.

Powering a Changing World

Power markets across Europe are being challenged by four often conflicting drivers:

1. Requirements to carry more power generated from remote renewable and nuclear sources of energy;
2. Requirements to increase the interconnection capacity between countries;
3. Requirements to increase system security while replacing ageing transmission assets; and
4. Increased planning delays for new overhead transmission infrastructure due to heightened public interest in environmental matters.

Transmission companies and cable manufacturers are searching for new ways to manage the response to these drivers.

By targeting problem locations for overhead transmission projects at the planning stage and by proposing underground cable solutions, developers can:

- Gain support from stakeholders who would otherwise oppose transmission projects;
- Reduce or eliminate planning delays so projects are completed on reliable timescales to satisfy investors, customers and regulators;
- Leverage the improved lifecycle cost of underground cables to control costs on the overall project; and
- Demonstrate to investors that business risk from emerging environmental and corporate social responsibility drivers is being managed effectively.

1. Environmental Module

Underground cables are especially effective at helping power transmission projects to cross areas where there are environmental sensitivities. These include areas that are:

- Close to homes, schools, and other human habitation
- Of outstanding visual value, either historical or natural
- Crucial to wildlife habitation and migration
- Environments that present natural obstacles, such as waterways

Underground cables are able to address these sensitivities as they offer:

- No visual damage after installation
- The ability to engineer external fields to almost zero
- No physical obstacle to animals or birds

Choose from the options below to learn more about the environmental aspects of underground cables:

1.1. Electromagnetic Fields (EMFs)

Electromagnetic fields are generated by electric currents and voltages in conductors. There is considerable concern about the health effects of long term exposure to these fields. While the perceived risks remain difficult to quantify, it is clear that the highest exposures and concerns occur when people live or spend significant potions of time near a power conductor.

The EU has issued standards that control the allowable exposures to EMFs, but at significantly higher levels than those found in the vicinity of power lines. The following are typical national positions on magnetic fields:

- International Commission on Non-Ionising radiation Protection, ICNIRP & EU recommendation 1999 - 100 μT
- 1996 Swedish Advisory Bodies suggest power distribution should avoid average exposures above 0.2 μT
- 1999 Swiss Government limit for new installations - 1 μT
- 2000 Three Italian Regions: Veneto, Emilia-Romagna and Toscana - limit for new installations near schools, nurseries, houses & places where people spend more than 4 hours per day - 0.2 μT
- 2002 New substation in Queensland, Australia: Energex Ltd - 0.4 μT
- 2004 The Netherlands Dept of the Environment proposal – 0.4 μT

Underground cables can help power projects to transmit power past sensitive areas of human habitation and address the concerns of stakeholders.

1.2. Land issues

Underground cables and overhead lines have significantly different footprints through the countryside when completed. While an overhead line requires a strip around 200 metres wide to be kept permanently clear for safety, maintenance, and repair, an underground cable of the same capacity requires only 10 metres or so.

With appropriate engineering works, such as magnetic shielding, a cable can even safely run under areas such as pedestrian zones with no exposure to external fields.

A recent study by the Swedish National Grid Company (Svenska Kraftnät) showed that a redesign of their grid could bring substantial benefits. By replacing 220kV lines with a mixture of 400kV overhead lines and underground cables, certain lengths of line could be completely eliminated. Benefits of the redesign included:

- Removal of 150km of lines, mostly from populated areas
- 60,000 residents will no longer live within 200 metres of a line

- 5,000 apartments could be built on abandoned rights of way
- Comparing the costs and benefits, for an up-front price of kr3.3B, land with a value of kr2.2B was released for development, potentially covering over 65% of the costs
- If electrical supply quality improvements were included, the benefits of the project covered the total investment costs

1.3. Recyclability

At the end of service life, a cable can be recovered for recycling or left in place. With older oil-filled cable technology, leaving the cable in place may have risks associated with long term oil leakage. Modern XLPE cables, however, can be left in situ with little risk of release of hazardous substances. Of course, good environmental stewardship dictates that recycling should be a preferred option for XLPE cables, if possible.

A modern cable has three recycling-related aspects to consider:

- Recovery of cables: Recovering a cable can require considerable excavation work, depending on the nature of the installation. Direct excavation is relatively costly, while physically dragging up the cable from the soil is significantly cheaper.
- Recyclability of copper: A large power cable system may have three conductors, each with a 2500 mm2 cross section of copper. Each kilometer of this cable contains around 25 tonnes of copper whose scrap value can cover the costs of recovering the cable from the ground. This copper is fully recyclable into new copper products of all types, including electrical grades and new cables. Recovering this copper saves around 70 tonnes of CO2 emissions.
- Dealing with cross-linked polyethylene: The polyethylene in a power cable is a special grade, which has cross-linked molecules to allow it to deal with extremely high temperatures without melting or flowing under load. This also means that it cannot be remelted once it has been stripped from a cable. This makes XLPE sheathing similar to rubber vehicle tyres, which are made from a cross-linked polymer. Options for dealing with cross-linked polymers include:
    - Energy recovery in cement kilns
    - Conversion into a crumb or power for use as a filler mixed with virgin material
    - Depolymerisation, the breaking down of the molecules into feedstock gases and feeding back into petrochemical processes

It is likely that given the low quantities of cable sheathing likely to enter the market, developing a specialist recycling route and associated specifications would not be worthwhile. Therefore, energy recovery is likely to be the most attractive solution, which displaces fossil fuels and avoids use of scarce landfill space.

2. Regulation

The transmission of power over long distances is a natural monopoly market and, as such, governments regulate the market to ensure that system operators maintain standards and do not over inflate prices.

Important issues controlled by regulation are:

- Security of supply, so that power is always available;
- Quality of supply, so that the voltage and frequency are stable and that voltage spikes do not

damage equipment; and
- Cost, so that a fair rate is charged for the service of transmission.

To control these issues, regulators apply a range of controls to areas such as maintenance, capital investment allowances, operating cost allowances, investment returns and asset lifetimes.

Choose from the topics below to learn more about how regulators work to ensure that consumers' interests are protected, whilst investors are able to make fair returns on their investments.

2.1. Basic mechanisms

The European power transmission network is recognised as an important factor for economic and social well-being. Within a country, system operators usually have geographical separation and, as a consequence, local monopoly status. Transmission systems are capital intensive, sized to meet demand, and fixed in nature, making it unlikely that any competition could arise to control prices.

Due to the central importance of energy and the natural monopoly status of the transmission system operator, transmission networks are regulated to maintain acceptable standards for stakeholders and prevent the disproportionate exercise of economic power by operators.

Multiple Requirements of Power Transmission

A power transmission system must reliably and cost effectively deliver power to customers while ensuring the return on investment required by the transmission system operator. Regulators attempt to achieve this balance through:

- Ensuring a safe and reliable transmission system by working with industry and consumer stakeholders to set and enforce meeting minimum reliability criteria;
- Agreeing with system operators on a set of overall cost effective investment guidelines linked to meeting the minimum reliability criteria;
- Working with broader stakeholders to balance the costs of transmission system investments with social, economic and environmental considerations;
- Ensuring that the system can respond to national imperatives to assist in the delivery of diverse and environmentally responsive primary sources of energy;
- Working with stakeholders concerned with national development to ensure that transmission solutions are used and expanded efficiently; and
- Maintaining regulatory oversight to ensure that balances are evolved to meet changing circumstances over time.

2.2. Regulatory drivers

The regulation of power networks in each European country reflects the influence of a number of drivers, some of which reflect local needs and some of which are a result of EU needs and requirements. The following topics provide an overview of the most important issues related to regulatory drivers.

EU Regulatory Environments for Power

Transmission

A 2004 survey among eight leading financial analysts conducted by the EURELECTRIC Network of Experts in Finance & Economics on the regulation of the European electricity sector looked at the different regulatory environments in Europe. It gave the following results.

	Best	**Worst**
Highest clarity	UK, Italy	Germany, Greece
Consideration of all stakeholders	Italy, Finland	Austria (favours distributors) Italy, Portugal (favours generators)
Transparency	UK, Italy	Belgium, Sweden
Incentives for participants	Finland, Italy, Netherlands	France, Spain
Incentives for cost reduction	UK, Italy	France
Length of price control period	UK, Italy	Belgium, Greece, Sweden

Financial Risks for Investors in Regulated Transmission Systems

The financial risks in regulatory systems include the following.

- In many countries regulatory price controls are set for five-year periods, whereas loans required to fund investment projects are taken out for much longer time frames. If the rates of return are not sufficiently adequate, the transmission system operators (TSOs) could face difficulty in raising the required funds.
- Credit ratings of stand-alone transmission companies often fare better than companies that are subsidiaries of integrated players. Stand-alone transmission companies have a clear focus on transmission, regulated rates and have visible separation from other potentially volatile segments of the industry (eg. generation and supply). They are also immune to the credit issues which can affect integrated multinationals, who may be seen to be pursuing over-aggressive expansion in other markets.
- Europe's transmission companies have a mix of ownership - some are state owned while others are private or subsidiaries of integrated companies. Public companies may be able to access equity as well as debt markets for capital, but state owned enterprises have more limited access to capital markets that can restrict investment plans.
- Underground cable projects are more expensive up front than OHL. Grid companies will have a natural concern that regulators will be reluctant to allow full recovery of the higher incremental costs from customers. Also investment projects are not "ringed fenced" from a regulatory perspective. The projects are added to the "regulated asset base". In these cases, it is important for

regulators to be persuaded of the consumer benefits of certain higher cost options, such as where underground cables assist in unblocking local protests against a new transmission project
- The economics of investment into new long distance transmission infrastructure have to be weighed against the alternative of building new generation capacity. The lengthy consents process for new lines can often mean it is more attractive to build new power plants, even if this is not the optimum solution.

Overview of EU Transmission Regulation

The principles for regulatory control and financial reward for infrastructure investment were established by the European Council of Energy Regulators in a March 2003 paper, "Principles of Regulatory Control and Financial Reward for Infrastructure". The paper established eight principles:

- Governments should encourage investment in electricity transmission infrastructure to implement the internal energy market, facilitate efficient competition and safeguard security of supply. Public authorities should maintain oversight of infrastructure decisions in order to promote both security of supply and network efficiency;
- Transmission system operators (TSOs) must manage their networks in an efficient manner;
- Public authorities should establish transparent, non-discriminatory and standardised options for the development of infrastructure and aim as far as possible to minimise regulatory risks;
- Public authorities should enforce a procedure for the publication of TSO infrastructure plans;
- TSOs must be effectively unbundled to ensure that there is no conflict of interest when making investment decisions and to ensure there are sufficient incentives to provide fair third party access;
- Public authorities should establish the regulatory regime for national and cross-border investments. Merchant infrastructures should be decided on a case-by-case basis and should continue to be subject to ex-ante regulatory control;
- Public authorities should guarantee that procedures applicable to granting required licences for new investment in electricity networks are non-discriminatory and efficient;
- Swifter, more expeditious administrative authorisation procedures are required for infrastructure development, particularly those for interconnection infrastructure.

Regulatory regimes

Regulatory regimes have intrinsic biases in their effects on the firms being regulated. To overcome these effects, regulators and other stakeholders need to carefully manage the process to avoid imposing perverse incentives on the companies. There are two broad methods for regulation - "Rate of Return capping" and "Retail Price Index - X" (RPI-X).

- With Rate of Return regulation, the firms that own transmission systems are allowed a given rate of return on their investments. Without checks and balances, this could incentivise companies to invest heavily to increase absolute levels of financial returns. If checks are insufficient, firms may be tempted to gold plate projects, maximizing invested capital whilst not necessarily giving the most efficient and cost effective infrastructure. Value for money guidelines are required to manage this.
- With RPI-X, firms are regulated on their transmission service charges, which are allowed to rise with inflation minus a factor of "X". This regulatory method is very effective for controlling prices, but may incentivise firms to underinvest in order to control their costs. This means, for example, that cheaper inefficient equipment may be procured, as the cost of losses is bourne by generators

and customers. Controlling this issue requires enforcement of quality standards.

Another issue for regulators is that in certain circumstances, it may be advantageous for firms to maximize their allowable annual operating expenditure within their regulatory regime, as these yearly expenditure allowances can offer a useful cashflow boost if the measures they are intended for can be delivered for less cost than originally agreed. When this underspend becomes apparent, the regulator will usually demand a transmission tariff adjustment to compensate consumers for the higher than required up-front payment. However this recovery may take place in the next control period, giving a useful cashflow advantage to the operator. There are reputational risks for operators who make a habit of over-estimating opex for this purpose, and regulators are very sensitive to requests of this type.

The Trans-European Energy Networks Programme

The Trans-European Energy Networks (TENS) programme provides about €25M per year to assist feasibility studies into cross-border power and gas transmission projects. This work is intended to create stronger cross border power trading in pursuit of internal markets, introducing competition and generating best pricing with reduced regulatory requirements. The work is an extremely important part of the European Commissions drive to ensure that European consumers have access to more reliable power at better prices.

The investments required to drive this are predicted in the table following:

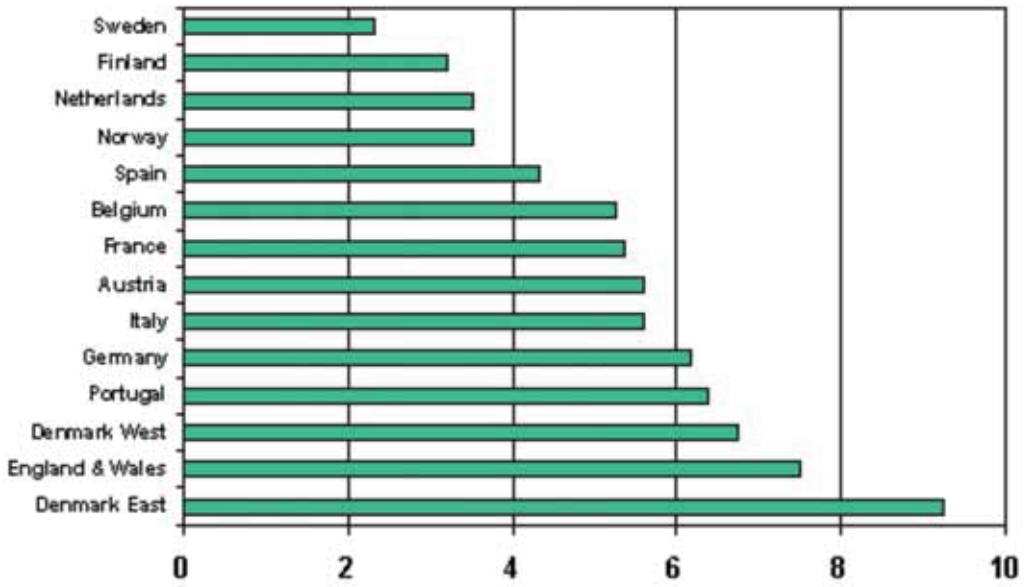
Projected Investment in Priority Axes of TEN-Energy for Electricity

	Priority Axis	**Additional Transmission Capacity MW**	**Investment €m**
EL 1	France-Belgium-Netherlands-Germany	2500	300
EL 2	Italy Borders	4000	600
EL 3	France-Spain-Portugal	3000	400
EL 4	Greece-Balkans-UCTE	2000	100
EL 5	UK-Continental Europe	2000	1,100
EL 6	Ireland-UK	500	300
EL 7	Baltic Ring	3000	700
EL 8	Central Europe	3000	500
EL 9	Mediterranean Ring	3000	1,000
Total		23000	5,000

Transmission Costs Across Europe

Transmission costs experienced by consumers vary with the age of the infrastructure, the cost of maintenance and upgrades and the allowable financial return to the transmission system operator. Transmission costs vary widely across Europe and some examples are given below:

Transmission Costs in Euros/MWh



2.3. Investment Behaviour and the Cost of Project Delays

The environment within which a transmission system operates, evolves and grows is a result of the interaction between the regulator and the companies that own and operate the system. The regulatory framework is designed to push for changes, drive down costs and allow investment in new infrastructure or practices that allow cost reduction or reliability over the long term.

The financial structure of the transmission system operator has an effect on its investment behaviour and differs mainly according to whether the company has a high or low proportion of debt. Debt must be serviced from current cashflows, while equity borrowing has to be paid from dividends and need not be paid in certain circumstances. The company will be likely to invest in different projects according to this relative cashflow requirement. For example, more highly geared companies (i.e., those with a high proportion of debt which must be serviced) might be more likely to make higher risk-higher return investments, while operators with low debt levels are more likely to be satisfied with lower but safer returns.

One of the issues that transmission system operators face is how to balance potential financial returns from a project against the costs of delay if there are public protests against proposed routes. The costs of delay include lost revenues to system operators, due to transmission capacity not being in place, and possible regulatory penalties if delays cause transmission quality to drop, for example if the system starts

to experience more faults due to overload.

Costs to industry and consumers from poor quality or supply interruption can also be significant and regulators will be interested in minimising these costs also.

In certain circumstances, operators can find that putting some sections of a project underground can help to unblock local opposition, allowing a project to proceed much sooner than if a judicial process is used to force a 100% overhead line approach. The savings from avoided delays can be significantly larger than the incremental costs of underground cables. However, transmission system operators must be able to prove these cost savings in making their case for investment to the regulator.

3. Underground Cable Case Studies

Underground cables have been employed in a range of situations to assist power project developers to overcome local problems. For example, shielded underground cables carry power through urban areas where overhead lines would be technically unfeasible or an unacceptable intrusion. In some cases, the hidden nature of cables has protected areas of outstanding natural beauty, such as the Vale of York in the UK or the Gudena Valley in Denmark. In other cases, cables have been substituted for overhead lines in order to allow new developments to work properly, such as at the new Madrid Airport.

View the following case studies for specific examples of where cables have been used effectively.

Case Study 1: Use of Cables in Areas of Outstanding Natural Beauty

The Denmark Aalborg - Aarhus line/cable is a classic example of the use of cables to protect areas of outstanding natural beauty.

To reinforce the 400kV network in the western part of Denmark, Eltra built a 140km link between Aalborg and Aarhus. The line, with a capacity of 1200MW, is mainly overhead but is buried in three sections in areas considered to be of scenic or ecological interest:

- Southwest of Aalborg, a 7km section was put underground in an urban area but also one of historical significance.
- Further south, the 150kV overhead line that crosses the Mariager Fjord was dismantled and 2.5km of 400kV and 150kV cable was laid.
- Still further south, a 4.5km section passing through the Gudena Valley was placed underground as OHL was not considered appropriate through a picturesque area of lakes and wooded hills.

The cables used were aluminium with a conductor size of 1200 m2 and were arranged in a double circuit in a trench at a depth of at least 1.2 meters.

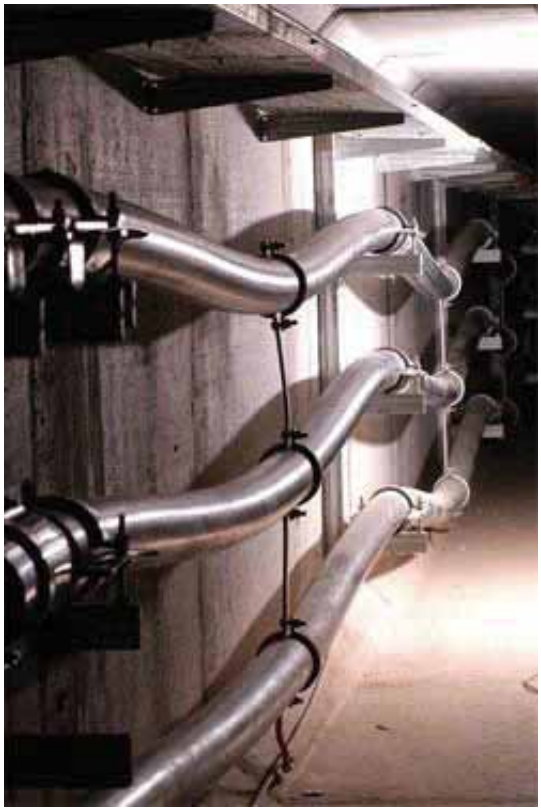
The total cost of the project was around €140m. The underground part represents about 10% of the total length and is estimated to have cost €35m (25% of the total). The project took 11 years of political negotiations, but only one year to engineer and two years to construct.

Case Study 2: Cables Enable Development of Valuable Project at Madrid Airport

Madrid's Brajas Airport is Europe's main airport for flights to Central and South America. When AENA, the Spanish airport authority, put in place a $3.5 billion project to double capacity up to 79 million passengers a year, three new runways were an integral element of the plan.

However, an existing 400 kV overhead transmission lines crossed the line of the runway. The transmission lines, owned by REE, Spain's main Transmission System Operator, were a key element of the grid serving the city of Madrid.

The importance of maintaining a stable supply to the capital meant the reliability and capacity of any solution was of the highest importance. The only technically feasible and cost effective solution was to replace the lines with 13 km of 400 kV cables in a tunnel under the new runways, with three parallel single core XLPE cables, each with a conductor cross-section of 2,500 mm^2.



PIRELLI
400 kV XLPE 1x2500 mm²
Red Eléctrica de España for "Barajas" airport - Madrid

Case Study 3: How Protests Can Delay Overhead Line Projects

The overhead line (OHL) transmission project through South Burgenland to Kainachtal (Steiermarkleitung) was proposed to transmit power between surplus generation in the north of Austria and consumption in the south. In addition, the project would have assisted in the European TENS programme to create a European-wide transmission grid. The project was designed to be 100% overhead lines and provoked considerable and ongoing protest:

- 1984 - Plans for the 90km 380kV line first mooted by Verbund
- 1988 - Opposition from municipalities commenced
- 1996 - Local referendum (51% of the eligible voters participated) and 93% opposed the OHL
- 1996 - Ministry of Economic Affairs commission expert opinions from Prof Edwin (Aachen) and Dr Glavitsch (Zurich) into the need for the line and Dr Kunze (Vienna) regarding EMFs. All concluded that the line should proceed
- 1997 - Styrian Provincial government commissions four expert reports to assess the importance of the project for the province
- 1998 - Expert reports presented, overall conclusion was "not to prevent the construction of the line," however an additional expert opinion was sought looking into alternatives to the 380kV line
- 2001 - Twenty-seven local communities agree to act in solidarity against the line
- 2003 - Regulator and Economics Affairs Minister (Bartenstein) call on the missing link to be completed; Verbund signs agreements with Steweag-Steg and Bewag to act as "partners"
- 2004 - Mayors of local communities submit 1,500 objections to the line
- 2004 - Environmental Impact Assessment (EIA) including 26 sub-reports carried out
- 2004 - Hearings into the proposed line and Styrian government asks Ministry of Economy to re-study link with a 20km underground section

- 2005 - OHL proposals contained within the EIA deemed environmentally friendly by authorities in Burgenland & Styria, but prescribe 160 conditions that must be met. One-hundred-forty-nine appeals lodged against the decision. Final decision from Environmental Senate is expected at the end of 2006.

Case Study 4: Cables Enable Reinforcement of the Grid in a Built-Up Area

When the UK's National Grid Company needed to provide extra power into North-West London to meet growing demand, it was not possible to provide the transmission capacity using overhead lines as such lines would require both extremely large towers and a wide right-of-way along a route that was already heavily developed. The alterative was to install underground cable in a tunnel, which would allow the project to run with very little above ground disturbance.

The final design involved a 20 km long tunnel running from Elstree in Herfordshire to St John's Wood in North London at a depth of around 20-30 meters below ground level - although the maximum depth is around 80 meters in one stretch. The tunnel has an internal diameter of 3 meters and contains a single circuit run of 400kV XLPE (cross-linked polyethylene) cable, the cable alone weighing almost 2,500 tonnes. The cables are maintained and inspected via a monorail-mounted inspection system. To future proof the project, the tunnel was built with capacity to hold another cable circuit. The project included seven head house buildings along the cable and two new transformer substations at each end and had a budget of £200M. The project started in March 2000 and was commissioned in September 2005.

In addition to using modern tunnel boring technology to offer almost no disruption to people above the tunnel line, the project also employed advanced monitoring and planning techniques to ensure that there were no collisions between the boring equipment and existing infrastructure.

Areas where care had to be taken included Staples Corner, where road bridges on the M1 have deep foundation pilings and existing utility structures such as the Thames Water Ring Main, a major sewer system and existing electricity cables.

The project forms an important part of the London Connection Project, which is intended to reinforce power transmission into London. Much of the existing 275kV infrastructure is coming to the end of its life and is undersized for projected demand. Progressively overlaying and replacing the 275kV lines with 400kV lines and cables will significantly improve capacity whilst maintaining continuity of supply to the UK capital.

The success of this project has prompted adoption of a similar unobtrusive tunneling approach that will be used to install a second 400KV cable circuit in the UK between Rowdown and Beddington in 2010.

Case Study 5: Building a Business Case for Power Projects in Sweden

Svenska Kraftnät, the national transmission grid system operator for Sweden, in 2005 presented its plans for redeveloping the transmission network in and around Stockholm, which supplies around 20% of the Swedish population with power. These plans were prepared from the point of view of a long term and

social benefit-based business case, examining issues such as quality of supply, environment, social and local development issues.

To prepare the business case properly, Svenska Kraftnät involved local government and local transmission network operators in a detailed examination of:

- Systems performance
- Effect of transmission infrastructure on land use
- Impact of power lines on social amenity
- Presence of sensitive receptors such as schools and private dwellings
- Effect of transmission lines on the natural landscape

These attributes of different system options were evaluated against three scenarios to ensure the best spatial and load match:

- Present day infrastructure and present day loads
- An evolution of the present day infrastructure supplying the predicted demand patterns for 2030
- A comprehensively redesigned network and 2030 demand patterns

The system options were designed in each case to be able to manage all (n-1) faults and some (n-2) faults.

How Transmission Systems Deal with Failures

A power transmission system must be able to supply power reliably under all conditions of demand on the network:

- Summer peak load;
- Summer off-peak load;
- Winter peak load;
- Winter off-peak load;

The N-1 criterion expresses the ability of the transmission system to lose a linkage without causing an overload failure elsewhere. The N-2 criterion is a higher level of system security, where the system can withstand any two linkages going down. Details that accompany the N-1 and N-2 criteria give further information on the robustness of the system.

An N-2 safety criterion may, for example, involve additional feed in points from lower voltage networks to provide reserve supply, so the low voltage network itself acts as a power conduit. Additional criteria may include a requirement for load shedding - knocking off certain large power consumers to maintain supplies for the rest of the network and rescheduling of generation - bringing on generation units at short notice that normally would not be used.

4. System Reliability

We tend to only notice electricity when it isn't available, such as when our central heating and water heating systems, clothes washing, or entertainment fails in our homes due to a power outage.

When power is unavailable over a wider area, much more serious impacts can occur. For example, water

supplies held in treatment plants without access to standby power can be threatened. For industrial users deprived of power, research has shown that the economic value of a lost kWh of electricity may be orders of magnitude higher than its purchase price.

Grid operators work very hard to ensure continuity of supply. Choose from the topics below to learn more about system reliability:

4.1. Reliability of Cables and Lines

A power transmission system must reliably deliver power of a given quality to all parts of the network. There are high economic and social costs if this is not possible. For example, grid outages may mean that commerce must close down unpredictably, leading to missed deliveries, lost batches or damage to equipment that cannot take shutdowns - such as glass furnaces. To manage unreliability, industries may need to maintain their own standby sources of power, which are costly and reduce competitiveness.

Performance standards ensure that power transmission systems are very tightly controlled. Choose from the topics below to learn more about the N-1 criterion for system reliability and how systems cope with failure.

How Transmission Systems Deal with Failures

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The N-1 criterion for power transmission

A power transmission system must be able to supply power reliably under all conditions of demand on the network:

- Summer peak load;
- Summer off-peak load;

- Winter peak load;
- Winter off-peak load;

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4.2. Failure Case Studies and Correction

Overhead lines and underground cable systems have failed in the past for different reasons. While early examples of both types of systems failed due to less comprehensive understanding of the technology, both systems have solved these problems. Failures specific to each type of system include the following:

The principal failure mechanisms for overhead lines include:

- Human accidents: aircraft, vehicle and direct personal contact
- Weather-related damage: excessive wind loading and ice loading
- Tree fall: damage to lines from falling trees

The principal failure mechanism for modern underground cables include:

- Human disturbance of the ground

Underground high voltage power cables are now not prone to damage from water and defects in cable joints, while high voltage overhead lines are less prone to metal fatigue and collapse.

To learn more about cable and line failures, choose from the topics below:

Case Studies and Impacts

Over the last few years, Europe and the US have experienced a number of significant power blackouts caused by transmission failure. The reasons for these failures are summarised below.

Where	When	Were Overhead Lines or Cables a factor?
Germany	Nov 2005	**Overhead lines**. On 25 November, around 120,000 consumers in the Munster region in Germany suffered four days without electricity after around 50 pylons on the 220kV and 110kV network collapsed in the wake of a heavy snowstorm. Some local communities were without power for a week

Italy	Sept 2003	**Overhead lines**. Tree fell across 380kV line in Switzerland causing initial disruption. Italian system became isolated and overheating of conductors on 380kV line (Sils-Soazza) in Italy led to sags in the line which led to contact with a tree and trips of generation plant. Recommendations include better right-of-way maintenance practices
Copenhagen	Sept 2003	**Neither**. Valve problems at nuclear power plant in Sweden led to its shut down. Other plants increased production but busbar failure at substation led to four 400kV lines being disconnected. This led to shutdown of other nuclear plant and a shortage of power in southern Sweden and eastern Denmark
North East USA/Canada	Aug 2003	**Overhead Lines**. Started with a tree flashover on 345kV line. There were 3 other factors but inadequate vegetation management re: tree pruning and removal a key reason
London & Birmingham	Aug/Sept 2003	**Neither**. These were due to problems with recently commissioned protection equipment at sub-stations. Maintenance procedures questioned
France	Dec 1999	**Overhead Lines**. Lines damaged by falling trees. Also many pylons were not able to withstand very high wind velocities. Investigation into the incident recommended increasing pylon wind velocity resistance from 150/160 km/hour to 160/170 km/hour. Accord between EdF, RTE and the government also agreed to underground 25% of future HV lines (63kV-150kV)
Auckland	Feb 1998	**Underground Cable**. Contractor cut through a 110kV UGC and three others had failed due to aging cables (two of which were over 50 years old) and high ground temperatures. Power was out for up to 7 weeks

Failure Statistics for Overhead Lines and Underground Cables

The best way to compare underground cables with overhead lines is through the availability of the system to transmit power. The UK National Grid published statistics that show non-availability of 0.126 hours per year per kilometer of 400 kV overhead line, compared with 6.4 hours per year for its 400 kV underground cables, some of which are old oil-filled lines. The international average for 400 kV cables appears to be around 3.4 hours per year. This reflects the fact that although cables suffer interruptions much less frequently than overhead lines, they do take longer to put back into service. However, despite difficulties claimed for repairing underground cables, cables in service are still available for 99.96% of the time.

Underground power cables are up to 90 percent cheaper to operate than overhead lines as they are out of reach of many of the accidents that can befall overhead lines. However, underground cables have much higher costs when a fault does appear.

Hydro Quebec estimated that a minor fault for an underground cable takes about five days to repair, compared with one day for an overhead line, whilst a major cable repair will take 20 days compared to 7 days for an overhead line.

Storm, Weather Damage and Accidents

Two major benefits of underground cables are that they are not susceptible to storm and icing damage and are far less likely to cause death or injury due to accidental contact with the lines/cables.

Minor storm damage to overhead lines across Europe is only a frequent event for low/medium voltage lines, as lines on the taller 400kV pylons are safely out of reach and the pylons are much more sturdily constructed.

When people come into accidental contact with overhead lines, the implications are extremely severe. Information from France shows that there were 19 deaths due to contact with overhead lines in France in 2000 compared to no deaths for contact with underground cables.

4.3. Technical Improvement

As transmission system operators have sought further solutions to assist them with their transmission projects, both cable and overhead line manufacturers have developed new solutions designed to improve the flexibility of their products and to reduce costs.

For overhead lines, the principal issue has been to improve the strength of towers whilst reducing the visual impact. For underground cables, the drive has been to reduce costs and to ensure that reliability expectations are met.

Advances in materials have ensured that the low cost potential of XLPE insulation materials in underground cable systems has been available in a reliable form for many years. Consequently, the key issues that transmission system operators have to consider are associated with maintenance and the detection of faults.

Choose from the topics below to learn more about how cables contribute to lower overall system maintenance and how new cable technology allows faults to be rapidly and precisely located and repaired.

Detecting faults

Modern underground power cables are sophisticated assemblies of insulators, conductors and protective materials. Within these components are temperature sensors, which enable cable operators to monitor conditions along the cable in real time.

An optical fibre is built into a protective metal wire and that metal wire is then incorporated into the normal "screening" of the cable - the outer winding of copper wires that prevents electric fields from being transmitted outside of the cable.

Optical fibres are extremely sensitive to temperature and measurable changes to the light transmitted are used to detect the temperature along the light path. Modern sensing techniques mean that the temperature along the fibre can be measured with a resolution of around a metre. Therefore, any factor that increases the cable temperature can be rapidly detected, including human disturbance, changes in the soil around the cable, damage to cable insulation, etc.

Installation

The use of new high performance materials, such as cross-linked polyethylene (XLPE), has allowed cable manufacturers to produce thinner, more flexible cables for a given electrical service. These cables can be produced, shipped and handled in longer lengths and are easier to handle during installation. This reduces manufacturing and installation time and costs because of longer production runs, reduced number of shipments, fewer cable joints and improved handling during installation.

Cables can be installed using a range of techniques, allowing costs to be controlled and installations to be engineered to suit the environments and risks that they face in service.

- Mechanised trench laying methods avoid extensive excavations and transport of material
- Trenchless methods of cable installation, such as thrust boring and directional drilling, reduce time installing cables around other infrastructure, such as motorways and railway crossings, or in sensitive rural areas where existing habitats must remain undisturbed
- Installation of cables in mini tunnels allow the use of longer cable lengths that save on joints, installation time and costs

The engineering around the cable can also be optimized to provide special levels of protection to the cable and to the surrounding environment. For example, in rural areas it my be appropriate for the cables to be direct buried in a trench, with labeling above the system only to warn farmers and constructors from inadvertent disturbance to the cable and its surrounding. In the urban environment, where construction and utilities maintenance is a constant disturbance hazard, cables may be laid in concrete ducts with

concrete lids. Lastly, the cable trench or conduit system may, in certain cases, be surrounded with metal shielding structures to ensure that minimal magnetic fields are emitted in service.

Maintenance

Transmission networks, as engineered systems, can be maintained according to regimes with different levels of sophistication and corresponding implications for effectiveness and reliability (after P Birkner, 17th CIRED International Conference on Electricity Generation, 2003).

- Low sophistication: Corrective maintenance that will only react when failures occur
- Basic: Time-based maintenance or preventive maintenance of devices within fixed time periods
- Advanced: Condition based maintenance based on the results of a self-monitoring or a diagnostic system
- Sophisticated value-led: Reliability-centred maintenance that takes into account the functional importance of the device regarding service availability as well as its condition

When examining the record of modern cable-based systems, the key innovations in cables that have improved reliability and reduced the need for costly maintenance procedures are associated with jointing the lengths of cable together. These improvements have allowed transmission systems to receive benefits from the increased current-carrying capacity of cables. When an area of an overhead line network needs repair or essential maintenance, having cables in strategic areas of the system can assist in re-routing power to ensure continuity of supply.

4.4. Testing and Development

Underground high voltage power cables are high value systems and manufacturers subject them to stringent testing regimes to ensure that components have been manufactured and joined together correctly.

Choose from the topics below to learn more about the standards and facilities applied to test cables:

Pictures of Testing Facilities

Ultra high voltage testing equipment

On-site testing of a power cable

Testing Standards

High voltage underground power cables must be tested in accordance with the standards of the International Electrotechnical Commission (IEC), which sets specifications for electrical equipment and systems. The IEC provides a framework for international discussion and collaboration, from which agreed upon standards emerge for use in national specification systems and procurement.

The standard for testing of underground cables and systems is IEC 62067:

IEC 62067 (2006-03): Power cables with extruded insulation and their accessories for rated voltages above 150 kV (Um = 170 kV) up to 500 kV (Um = 550 kV) - Test methods and requirements

The standard can be purchased from the IEC.

The standard identifies that a high voltage underground power cable is a heavily integrated system and that the components cannot be meaningfully tested in isolation from each other. This requirement means that cable manufacturers have invested considerable sums to ensure that cables and components are not only tested before dispatch, but that they are also effectively tested at each stage of installation.

5. Life Cycle Module

Underground cables cost more per kilometer than overhead lines, but are a valuable solution where overhead lines are unacceptable. Europacable has published a position paper explaining its views on where the higher costs of cable should be accepted in power projects.

However, there is a considerable confusion about exactly how much more cable costs. When thinking about a power project, you must consider the costs over the life cycle of the system installed as well as the up front costs:

- The up front cost is paid in the first instance
- The life cycle cost includes not only the up front cost, but also the costs of maintenance and cost of power losses in the system over time

Efficient systems of any kind usually cost more up front, but save money in the long term. This module seeks to explain this situation for cable projects.

Choose from the options below to learn more about the life cycle of underground cables:

5.1. Installation Costs

Cables are more expensive than overhead lines, but given that cables are a developing technology, it is intuitive that costs to install cables will reduce faster than those for long-established overhead line technologies.

Cables also require less land than overhead lines, and as land becomes more valuable, the effect of value lost in providing portage for lines will have an increasingly beneficial effect on the overall cost of cable projects.

Europacable produced a position paper describing where and how much of a role cables should play in transmission projects. Europacable advocates that life cycle costs should be considered when analysing the relative costs of cable and overhead lines.

However, even when considering just the up front costs, there is considerable disagreement in the analysis available:

- A recent report by Eurelectric indicates cost ratios between cable and lines of 10-25 to 1
- “Undergrounding of Extra High Voltage Transmission Lines

Relative Cost Figures

The table below illustrates various claimed installation cost ratios between cables and lines.

Country	220kV Cable vs. Overhead Line	380kV Cable vs. Overhead Line	Source of Data
Austria – Verbund APG	-	8	Hearings into proposed Styria line
Denmark – Eltra	4.0	4-5	Aarhus/Aalborg line/cable
France – RTE	2.2-3	10	RTE website
Germany	-	10-20	Eurelectric report on public acceptance of new OHLs
Ireland – ESBNG	6-10	-	EIA into proposed new line
Italy - Terna	5.5	5.9	Regulator
Netherlands – Tennet	-	6	Paper comparing costs for ICF
Norway – Statnett	4.5	6.5	Stattnett website

Spain	-	25	REE website
UK – National Grid	-	15-25	National Grid website & brochure
ETSO	-	10-12	Paper on undergrounding

Relative Costs When Life Cycle Issues are Included

Comparing basic up front costs between cables and OHLs:

Cabled section length (km)	**5**	**10**
Capex/km XLPE cable €k[1]	9,678	8,845
Capex/km OHL €k	1,522	1,522
Cost ratio – cable cost ÷ OHL cost	6.4	5.8

When different life cycle factors are included in the 5km example:

Life cycle costs for 5km sections	**XLPE ÷ OHL**
Discounted present cost at 3% discount rate (DPC)	6.4
DPC including maintenance & decommissioning	6.1
DPC including maintenance, decommissioning & losses	4.0

5.2. Transmission Losses

Transmission losses are the power losses in an electrical system and are typically around 5-7% of the total power put into the system. Transmission losses represent a loss in value and an increase in fuel burn and environmental impact, as every MWh of power that is generated but cannot be sold costs money.

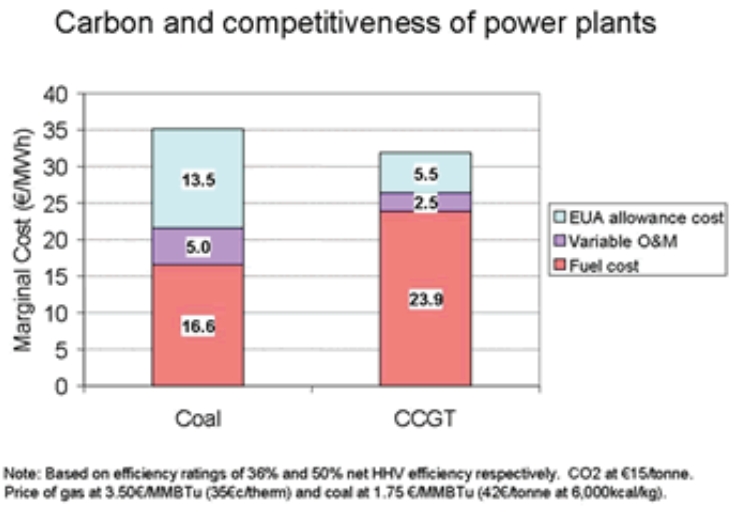
Transmission losses are caused by:

- The electrical resistance of the conductor lines (accounts for 5% losses or 147 million MWh)
- Converting the power between high voltages used for long distance transmission and safe low voltages used in most industry and the home (accounts for 2% losses or 55 million MWh)

In Europe, the resistive loss in transmission lines alone represents the waste of around 20 million tonnes of coal, 3.1 million tonnes of gas and 1.7 million tonnes of oil. The annual loss in value is around €12 billion. The annual increase in greenhouse gas emissions is around 60 million tonnes of CO2 per year.

In some countries, older transformer infrastructure and lines can yield losses as high as 21%. To learn

more about these older systems, visit the website of the UNEP Risoe Centre on Energy, Climate and Sustainable Development (URC), which has a useful paper explaining issues associated with Indian power infrastructure.



The cost breakdown of a delivered MWh of CCGT power

5.3. Planning Delays

Transmission companies can assist in delivering against national environmental and economic targets by solving delays to power projects through application of underground cables in problem areas.

Linking in remote wind power can depend on a single high capacity transmission project. If renewable power is not available, fossil fuel stations must be run to satisfy demand.

The International Energy Agency estimates that by 2020, 137GW of new power generation capacity will be needed in Europe, including 51GW of wind power. These wind projects offer a considerable quantity of emissions-free energy.

Delaying Wind Power in the UK

In the UK, high quality wind resources lie off the western coast, remote from consumers. The UK has an ambitious wind installation programme with about AAAMW of capacity being installed every year on average.

Wind power installation depends on transmission capacity being available to take the power. The economics of wind energy are supported by a green certificate scheme called the renewable obligation.

Every MWh of wind energy is given a certificate, which is worth around €65. A year's delay in starting delivery of 1GW of wind capacity means that:

- Renewables generators miss out on certificate revenues as high as €150M and power revenues as high as €130M.
- UK fossil fuel generators will have to emit as much as 1 million tonnes of extra CO2 at a cost of €15-€25 million in purchased emissions allowances.

The UK power sector has a target to reduce 5.5 MT of CO_2 in phase I of the EU ETS and a similar, but possibly larger amount in Phase II. A 1MT shortfall represents around 20% of the target and a major gap to bridge with other measures.

5.4. Replacement Cycles

An overhead line is exposed to the elements and depends on the air to remove heat from resistive losses. It is subject to damage from:

- Natural exposure and corrosion
- Fatigue from frequent cycles in temperature as current loads and air temperatures change during the day
- External influences such as excessive wind or ice loads, trees falling or hitting lines, or from accidental human interference

There is nothing that can be done about the problems suffered by overhead lines and the problems are built into a maintenance programme for a line over time. Typically an overhead line cable will be replaced every 15 years, while the towers will have a lifetime of around 40-50 years.

Underground cables are buried within engineered trenches or ducts. They experience no weather exposure and very stable operating temperatures. They are less prone to degradation. However, they are vulnerable to being disturbed by:

- Humans during excavations for buildings or drainage systems
- Ingress of tree roots
- Changes in soil moisture levels leading to overheating

The problems faced by cables can be dealt with through well-developed precautionary measures to minimise the chance of their occurrence. An underground cable is designed to last 40 years, but will probably last significantly longer, making a considerable difference to the life cycle economics of the cable compared with overhead line solutions.

HVDC is the key to an integrated European power network

The goal of European energy policy is to provide a secure, sustainable and competitive energy supply for all European citizens and companies.

Electricity is central to this goal because it can be generated from a variety of sources (including renewable sources), and because millions of people use it every day.

To ensure that electricity supplies are maintained, the European Union wants to hasten the integration of dozens of electrical grids across the continent and establish a competitive, secure, transparent and completely harmonized Europe-wide internal electrical energy market.

Key role for HVDC

High-voltage direct current (HVDC) transmission technology, developed by ABB 50 years ago, is playing a key role in the realization of this vision because of its unique capabilities. In particular, HVDC can provide fast, precise and flexible control of transmission flow, which greatly improves grid reliability, capacity and efficiency.

The EU's goal is to increase cross-border cooperation in Europe's electrical power market, but working out the details of multi-national transmission, harmonized grid safety standards, cross-border market access and renewable energy trade is no easy task.

Historically, European grids were not designed for the long-distance, cross-border exchange of power, but times are changing. For example, in July of this year, eight transmission system operators in Central Europe set up an office to allocate cross-border electricity transmission and provide payment within their region.

Develop existing networks

As part of the continuing harmonization process, the EU also wants to adapt, upgrade and develop existing transmission networks to eliminate transmission bottlenecks and congestion, and efficiently integrate electrical generation from renewable sources, such as wind and solar.

Meanwhile, public acceptance of visible new power infrastructure in populated or environmentally sensitive areas remains low, which means new power infrastructure must tread upon the landscape as lightly as possible.

Consequently, new ideas are needed to balance Europe's requirement for secure, reliable, and sustainable power with a low tolerance for extending infrastructure in sensitive areas.

DC an ideal solution for long-distance and underwater transmission

HVDC transmission technology is an ideal solution, and has some key advantages over the alternative, alternating current (AC):

- Power flow in a DC transmission line can be precisely controlled. This stabilizes the transmission network, and prevents the cascading outages that have occurred in Europe and the U.S. in recent years

- Electricity can flow in both directions in a DC link, so that demand and supply can be balanced more effectively, which also enables power trading. HVDC systems are widely used to connect asynchronous (ie incompatible) grids or networks, so that power can be exchanged between them.

- DC electromagnetic fields share the same characteristics and magnitude as the earth's natural magnetic field, which is all around us. When using two conductors, one plus and one minus, the electromagnetic field in DC transmissions is negligible.

- DC is the only option for the underground and underwater transmission of power over distances of more than about 50 kilometers

- DC power losses are significantly lower over long distances. A 2.000-kilometer DC transmission line at 800 kilovolts loses about 5 percent of its power to heat, while the power losses in an AC line of similar voltage are about twice as high

- DC transmission uses a much narrower transmission corridor than AC (see illustration)

These advantages, particularly in controlling the power flow and facilitating power trading, led the EU in 2003 to identify 22 interconnections as priority projects. Five have been built so far.

The surge in interest in this 50-year-old technology can be seen in the number of projects carried out in recent years. In the last decade, 17 HVDC links have been built in Europe, compared with 27 in the previous 40 years. Several more HVDC projects are currently under construction.

Table: Selected project examples in Europe

Project	Country	MW	Year	Main purpose
SwePol	Sweden-Poland	600	2000	Subsea cross-border connection
Italy-Greece	Italy-Greece	500	2001	Subsea cross-border connection
Troll A	Norway	84	2005	Power to offshore gas platform from shore
Estlink	Estonia-Finland	350	2006	Underground/subsea cross-border connection
NorNed	Norway-Netherlands	700	2008	Subsea cross-border connection
Nord E.ON 1	Germany	400	2009	Underground/subsea offshore wind park
SAPEI	Italy	1000	2009	Subsea island connection
BritNed	UK-Netherlands	1300	2009	Subsea cross-border connection

ABB celebrates landmark power technology

2009-11-19 - HVDC Light, the technology that made remote offshore wind farms possible, turns 10 today

Zurich, Switzerland, Nov.19, 2009 – ABB, the leading power and automation technology group, today celebrates the 10th anniversary of the world's first commercial HVDC Light installation, a technological innovation that opened up new possibilities in power transmission.

ABB pioneered high-voltage direct current (HVDC) transmission technology more than 50 years ago, and the introduction of HVDC Light 10 years ago represented a landmark evolution that enabled a host of new applications including wind parks far out at sea and underground power transmission over large distances. The new technology has been sold to four continents over the past decade.

Direct current transmission technology has lower losses and a smaller footprint than alternating current systems (AC). HVDC Light is based on voltage-source converters (VSCs) and uses IGBTs (Insulated Gate Bipolar Transistors) to convert electrical current from AC to DC.

A 10 kilovolt (kV) trial HVDC Light transmission system completed in Hällsjön-Grängesberg, Sweden in 1997 was followed by the commercial HVDC Light installation on the Swedish island of Gotland 10 years ago today.

In the 1990s, the island of Gotland, situated 90 km off the Swedish coast in the Baltic Sea, had already installed more than 40 megawatts (MW) of wind power capacity and significant new installations were planned. This not only required additional transmission capacity, but also a way to maintain power quality, because intermittent wind power generation can result in flicker and variations in reactive power.

Since Gotland went live, more than 20 converter stations have been commissioned, connected by about 1,500 km of HVDC Light cables, and using in total more than 28,000 IGBTs. Work is currently in progress on the following deliveries:

- BorWin1, the first grid connection of a remote offshore wind farm. The 400 MW wind park is located 125 km off the German coast in the North Sea
- East West Interconnector, a 256 km-long, 500 MW transmission link between Ireland and Wales
- Caprivi Link Interconnector, a 970 km-long, 300 MW transmission link in Namibia

HVDC Light has reached an important milestone and is now available at a power level of 1,100 MW, creating new possibilities for transmitting power over longer distances. Other applications using HVDC Light technology include the reinforcement of existing power networks; feeding isolated loads into the power network from offshore generation sites; and transmitting electric power from remote sustainable sources to the places where people live and work.

ABB (www.abb.com) is a leader in power and automation technologies that enable utility and industry customers to improve performance while lowering environmental impact. The ABB Group of companies operates in around 100 countries and employs about 120,000 people.

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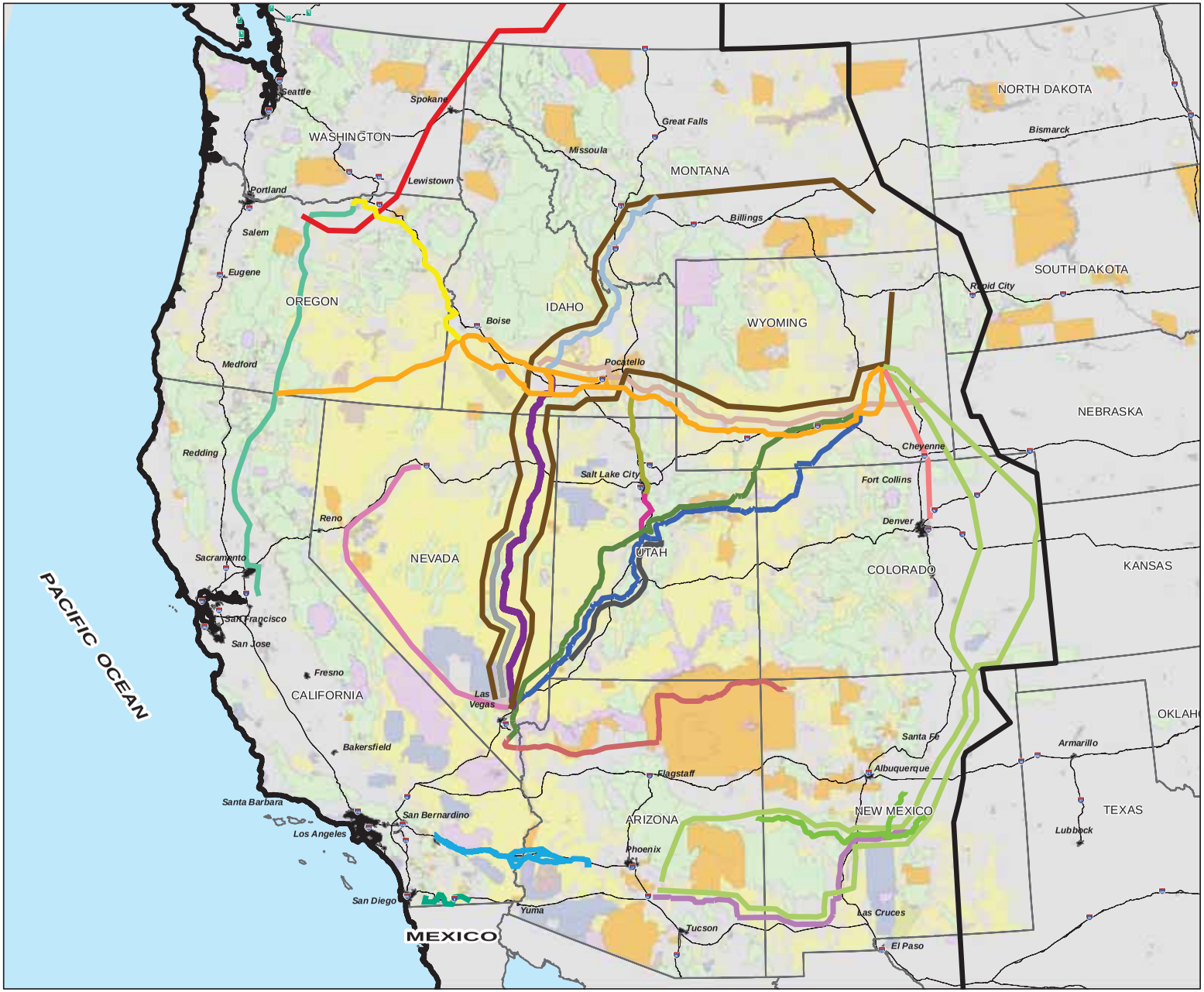
Links

- Pictures for download
- Gotland HVDC Light project web page
- ABB technologies that changed the world - Part one: HVDC

Videos (opens in external player)

- Gotland HVDC Light (4:24 min, large, 13 MB)
- Gotland HVDC Light (4:24 min, small, 1,3 MB)



Potential High Voltage Transmission Line Projects In the Western United States

LEGEND

Transmission Line Corridors Within WECC

- Gateway South Project
- Gateway West Project
- TransWest Express Project
- Mountain States Transmission Intertie Project
- Northern Lights Celillo Project (Conceptual)
- Northern Lights Inland Projects
- Wyoming to Colorado Intertie Project (TOT3)
- Boardman to Hemingway Project
- Southwest Intertie Project
- Overland Intertie Project
- Sunzia Project
- High Plains Express Project (Conceptual)
- Navajo Transmission Project
- Palo Verde to Devers Project
- Sigurd to Red Butte Project
- First Wind Project (Conceptual)
- One Nevada Transmission Line
- PNW/Canada - Northern California Project (Conceptual)
- Mona to Oquirrh
- Populus to Terminal
- Sunrise Powerlink
- Winnemucca to Harry Allen

Jurisdiction/Ownership

- Bureau of Land Management
- Bureau of Indian Affairs
- U.S. Forest Service
- National Park Service
- Department of Defense
- U.S. Fish & Wildlife Service
- State/Private

REFERENCE FEATURES

- State Boundary
- WECC Boundary
- Interstate
- Highway

0 20 40 80 120 160 Miles

Data Source Information

Land Ownership: BLM Denver Service Center, 2007.

NOTE: Transmission corridors are schematic and do not represent precise locations.

Prepared For:

Prepared By:

March 10, 2009

WESTERN RESOURCE
ADVOCATES

To: PacifiCorp IRP Team
From: Western Resource Advocates
Date: March 24, 2011
Re: Comments on the Draft 2011 IRP

WRA appreciates the opportunity to provide initial limited comments on PacifiCorp's draft IRP. The draft was issued the evening of March 7; comments were requested on or before March 24, and the final draft will be submitted to Commissions with jurisdiction over PacifiCorp on March 31. Given the short timeframe for review and the even shorter timeframe for PacifiCorp to respond to comments prior to final filing, WRA recognizes the limits of this exercise. Nevertheless these initial comments provide an opportunity to outline areas of concern.

WRA's primary concern with this IRP is the conduct of the public input process and the adverse effect that has had on developing a satisfactory plan. An opportunity to develop a shared understanding of the cost/risk tradeoffs of alternative resource acquisition and retirement strategies to meet an uncertain future has instead become an expensive regulatory exercise. Past Commission orders have been only superficially complied with; information that PacifiCorp agreed to provide has not yet been made available;[1] modeling results that were apparently completed and could have been released in a more timely manner have been delayed without explanation, thereby circumventing stakeholder input and requests for further information; and PacifiCorp appears to have applied modeling constraints, assumptions, and methods to achieve a pre-determined planning outcome. In addition, training in the use of PacifiCorp's planning models has been delayed.

PacifiCorp's 2008 IRP Update signaled a shift in the Company's strategic planning direction and approach to resource planning that is continued with this IRP. Without analysis, approximately 500 MW of renewable and distributed resources were removed from the 2008 IRP Preferred Portfolio and the renewable resources that remained were delayed until late in the first half of the twenty-year planning period. System Optimizer was then used to optimize the unmet need with natural gas-fired resources and short-term market purchases. The resulting portfolio constituted the 2010 Business Plan.

[1] Some of this information may be found in Volume II or may be in the supplemental information to be filed at a later date.

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The draft 2011 IRP formalizes this strategic direction. The selected preferred portfolio as modified is closely akin to the 2010 Business Plan Portfolio.

A number of assumptions and modeling decisions contribute to the selection of the modified preferred portfolio. Renewable resource types available to System Optimizer are unnecessarily constrained over the first half of the planning period. Wind integration and capital cost assumptions are high relative to other sources. The Production Tax Credit is assumed to expire at the end of 2014 instead of continuing through the planning period, as it was in the 2008 IRP. In addition, PacifiCorp appears to have vacillated in its use of "high" and "low to high" CO2 costs to drive particular outcomes. Finally, the stochastic modeling of future loads was significantly changed (without seeking stakeholder input), thereby reducing the apparent risk mitigating benefit of renewable resources.

An IRP designed to develop an analytical basis for previously determined strategic management direction, rather than to serve as the analytical foundation for developing the Company's strategic business plan, is troubling. In Utah, PacifiCorp just received regulatory approval to implement, at the end of the current rate case, an energy balancing account that will pass through to customers the majority of the risk that actual operating costs exceed the expected costs at the time resource decisions are made. And, in the current rate cases in Utah and Wyoming, the Company is seeking cost recovery for significant capital additions that have not been evaluated as part of the IRP process. Neither PacifiCorp's decision to build out its transmission system, nor the economic viability of investing in the environmental controls necessary to bring PacifiCorp's aging coal fleet into compliance with EPA regulation of emissions and fly ash, has been meaningfully analyzed. Although the Oregon Commission gave specific direction that coal retirement be evaluated as an option, PacifiCorp's analysis treats the investment in pollution controls as sunk; the ability to avoid these costs through early retirement is not an option.

Throughout this IRP process, limitations on time and Company resources have been given as reasons to limit analysis, stakeholder input, and access to information. WRA hopes PacifiCorp's intention to supplement the information provided in the filed IRP is an indication that the Company is reconsidering its approach. We look forward to reviewing the information contained in Volume II and the supplemental filing and hope to find the transparency and meaningful evaluation we are seeking.

For Immediate Release June 13, 2011

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Administration Announces Grid Modernization Initiatives to Foster a Clean Energy Economy and Spur Innovation

The Obama Administration today announced a number of new initiatives designed to accelerate the modernization of the Nation's electric infrastructure, bolster electric-grid innovation, and advance a clean energy economy.

Aimed at building the necessary transmission infrastructure and developing and deploying digital information or "smart grid" technologies, these initiatives will facilitate the integration of renewable sources of electricity into the grid; accommodate a growing number of electric vehicles on America's roads; help avoid blackouts and restore power quicker when outages occur; and reduce the need for new power plants.

The White House also released a new report by the Cabinet-level National Science and Technology Council (NSTC) that delineates four overarching goals the Administration will pursue in order to ensure that all Americans benefit from investments in the Nation's electric infrastructure: better alignment of economic incentives to boost development and deployment of smart-grid technologies; a greater focus on standards and interoperability to enable greater innovation; empowerment of consumers with enhanced information to save energy, ensure privacy, and shrink bills; and improved grid security and resilience.

"A 21st century grid is essential to America's ability to lead the world in clean energy and win the future," said John P. Holdren, President Obama's science and technology advisor and Director of the White House Office of Science and Technology Policy, which released the NSTC report: *A Policy Framework for the 21st Century Grid*. "By unlocking the potential of innovation in the electric grid, we are allowing consumers and businesses to use energy more efficiently even as we help utilities provide cleaner energy and more reliable service."

Holdren was among several high-level Administration officials who described the new initiatives and report at a White House event that also featured private-sector leaders and other innovators from across the Nation.

"America cannot build a 21st century economy with a 20th century electricity system. By working with states, industry leaders, and the private sector, we can build a clean, smart, national electricity system that will create jobs, reduce energy use, and expand renewable energy production," said U.S. Energy Secretary Steven Chu.

Smart grid technologies provide a foundation for innovation by entrepreneurs and others who can develop tools to empower consumers and help them make informed decisions. A first generation of innovative consumer products and services—such as thermostats that can be controlled from a smart phone, or websites that show how much energy a house is using—are already helping Americans save money on their electricity bills, and there is great potential to do even more. Similarly, the adoption of distributed energy generation sources (such as solar panels on rooftops), emerging energy storage technologies, and electric vehicles are all spurring changes in how and when energy is being used by businesses and consumers.

"This is one more step in our effort to modernize rural America's electric grid," said Secretary of Agriculture Tom Vilsack. "Smart grid technologies give consumers greater control over their electric costs and help utilities efficiently manage power generation and delivery."

Among the public- and private-sector initiatives announced today:

- $250 million in loans for smart-grid technology deployment as part of the US Department of Agriculture's Rural Utility Service, which is focused on upgrading the electric grid in rural America.
- The launch of *Grid 21*, a private sector initiative to promote consumer-friendly innovations while ensuring proper privacy safeguards and consumer protections. *Grid 21* will help consumers get better access to their own energy usage information so that they can take advantage of new tools and services to manage their energy use and save on their utility bills.
- New commitments by the Department of Energy to focus on improving consumer access to their own energy information, including the development of a crowd-sourced map to track progress, a data-driven competition designed to harness the imagination and enthusiasm of America's students to encourage home energy efficiency, and new EIA efforts to measure progress.
    - Consumers deserve access to their own energy usage information in consumer-friendly and computer-friendly formats. The Administration is committed to

working with States and stakeholders to ensure all Americans can take advantage of new tools and services to manage their energy use and save on their utility bills. With proper privacy safeguards and consumer protections, a smarter electricity system can benefit all consumers.

- Expanded partnerships to continue working with States and stakeholders, including an initiative to share lessons learned from Recovery Act smart grid investments, a series of regional peer-to-peer stakeholder meetings, and updated online resources available at: www.SmartGrid.gov.
- The formation of a Renewable Energy Rapid Response Team, co-led by the White House Council on Environmental Quality, the Department of the Interior, and the Department of Energy, to improve Federal coordination and ensure timely review of proposed renewable energy projects and transmission lines, to ensure that renewable energy can power cities and towns across America, and to increase reliability and save consumers money by modernizing the grid.

These efforts build upon the historic $4.5 billion in grid modernization investments provided for in the Recovery Act—matched by contributions of more than $5.5 billion from the private sector—to modernize America's aging energy infrastructure and provide cleaner and more reliable power.

"Modernizing our Nation's electric grid plays a critical role in advancing America's clean energy economy," said Nancy Sutley, Chair of the White House Council on Environmental Quality. "These next steps will help us transition toward the economy of the future and provide a boon for domestic job growth."

Even in today's information age, many utilities don't have real-time information about the state of the grid or know when their customers have lost power. A modernized electric grid can bridge these lingering information gaps while serving as a platform for innovation and helping to create jobs of the future. To secure our clean energy future, the Administration will continue to invest in transformational technologies and remove barriers for entrepreneurs to bring those technologies to market.

A detailed fact sheet and the NSTC report are available at www.whitehouse.gov/ostp

##

THE WILDERNESS SOCIETY

ECOLOGY AND ECONOMICS RESEARCH DEPARTMENT

SOCIO-ECONOMIC FRAMEWORK FOR PUBLIC LAND MANAGEMENT PLANNING: INDICATORS FOR THE WEST'S ECONOMY

Michelle Haefele, Ph.D.
Pete Morton, Ph.D.
Nada Culver
March 2, 2006

I. PURPOSE

This brief is submitted as part of the NEPA process for this land use proposal. It is intended to identify issues that must be analyzed in the plan and offer methodologies to assist agencies responsible for analyzing the socio-economic impacts of proposed land use decisions on Western economies.

In making land use decisions, federal agencies have an obligation under the National Environmental Policy Act (NEPA) to take a "hard look" at the environmental consequences of a proposed action, and the requisite analysis "must be appropriate to the action in question." This brief presents a framework and indicators to be used in analyzing the impact of public land management proposals on the economies of Western communities. Federal agencies cannot evaluate the consequences of proposed decisions or determine how best to avoid or mitigate negative impacts without adequate data and analysis. Through the application of the methodology we have provided below, using data collected from identified sources and measuring potential impacts through key indicators, federal agencies can better fulfill their obligations to evaluate the direct, indirect, and cumulative socio-economic impacts of various alternative decisions.

II. INTRODUCTION

We have organized this paper to facilitate the identification of key issues related to the impact of federal public land decisions on Western economies, and to provide key indicators for analyzing the impacts of those decisions on the economy of the West. The first section describes the changing economy of the western region, and how public land management planners should evaluate the economic impacts of land management alternatives. Next, we present key economic indicators with which to measure the vigor of the West's economy and discuss the implications of these indicators for the selection and analysis of land management alternatives.[1] The third section presents sources of data that are readily available at the state and county level, to which land managers should refer when preparing economic analyses for public lands. Next we outline the methodology we recommend agencies use to analyze the economies of western communities, in order to fully account for information that is traditionally absent in public land management assessments. Finally we provide a detailed list of our NEPA scoping questions, including specific recommendations for analyzing economic trends and conditions affected by the proposed management decisions.

These analyses and methods provide a necessary, but by no means sufficient, framework for the evaluation of proposed land management decisions. Socio-economic impacts are only one facet of the total impact of such decisions on communities. Western federal public lands belong to all Americans, and in order to fully evaluate the merits of land management decisions a complete benefit-cost analysis, including non-market values, must be made. While the specific methods for benefit-cost analyses are beyond the scope of this brief, we expect the agency to implement benefit-cost analyses in addition to the requested socio-economic impact analyses outlined here.

III. OVERVIEW OF THE WESTERN ECONOMY

In the last 30 years, the West has evolved from a region largely focused on extractive industries into a much more diverse area with a more diversified economy (Bennett and McBeth 1998, Johnson 2001). Table 1 shows the current proportion of total personal income from resource extraction industries in the Rocky Mountains. Recent research shows that most western counties are not "resource dependent," and have instead developed diversified economies

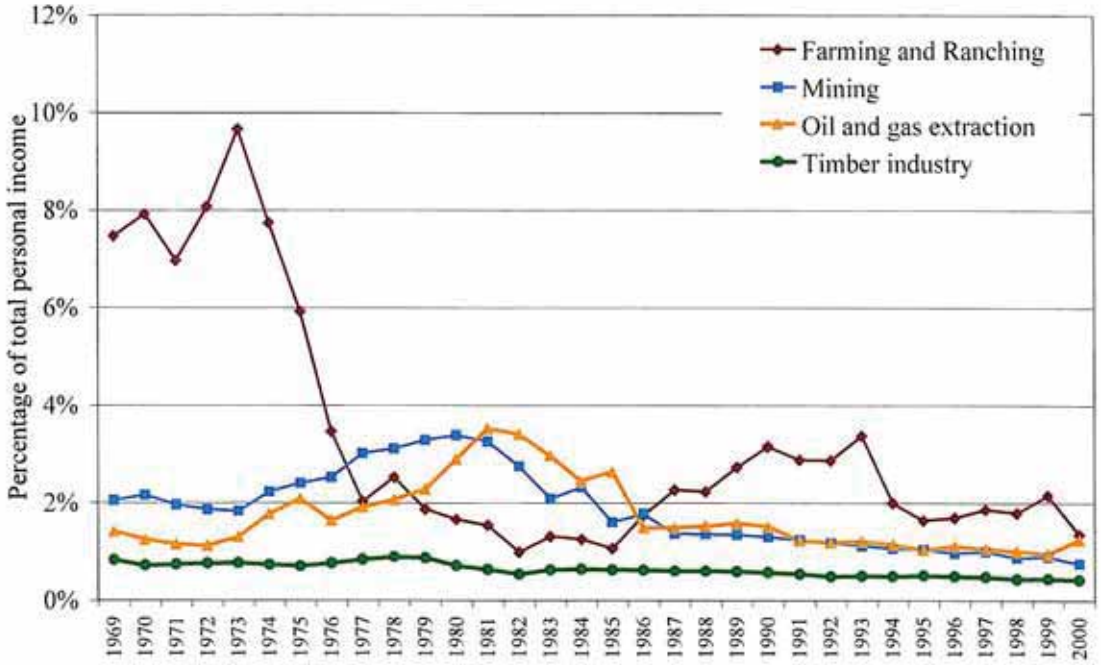
[1] We provide examples of the statistics and data available to analyze each of the key indicators. These examples focus on the five Rocky Mountain states, but the methods and analyses presented apply to other states throughout the region. The states we focus on in this brief are: Colorado, Montana, New Mexico, Utah, and Wyoming. The Western states, especially the Rocky Mountains, are currently facing accelerated development of oil and gas on their federal public lands while at the same time realizing the potential embodied in the amenity-based economy.

based on recreation, tourism, knowledge-based industries and the service sector. A recent study examining the impact of public lands on economic well-being in 11 western states found that only 3 percent of western counties could be classified as resource-extraction dependent (Rasker et al. 2004). Figure 1 shows the 30-year trend in resource extractive industry income in the Rocky Mountain Region. Public land management decisions all too often rely on a misconception of a resource-extraction-dependent rural West. Given the changing nature of the western economy, such assumptions exclude important non-extractive economic drivers and may even harm the economy of the region in the long run by depleting the natural capital responsible for the economic growth of Western communities.

Table 1. Extractive Industry Income as a Percentage of Total Personal Income (2003)

	Colorado	Montana	New Mexico	Utah	Wyoming	Rocky Mountains
Farming and ranching	0.77%	1.19%	2.52%	0.73%	2.11%	1.14%
Mining (excluding oil and gas extraction)	0.47%	1.49%	1.41%	0.71%	6.99%	1.09%
Oil and gas extraction	0.88%	0.44%	1.10%	0.16%	2.79%	0.84%
Timber industry	0.25%	1.40%	0.19%	0.39%	0.23%	0.35%
Total extractive industry income	2.37%	4.52%	5.22%	1.99%	12.11%	3.43%

Source: Regional Economic Information System, Bureau of Economic Analysis (http://www.bea.doc.gov)



Source: Regional Economic Information System, Bureau of Economic Analysis
Farming and Ranching: "Farm proprietors' income," "Farm earnings," "Agricultural services," and "Fishing"
Timber Industry: "Forestry," "Lumber and wood products," and "Paper and allied products"
Mining: Includes all segments of Mining sector except "Oil and gas extraction"
Note: The figure is based on SIC data for 1969-2000 in order to show the long-term trend. While not explicitly compatible, NAICS data for 2001-2003 show similar trends for extractive industry income and illustrate the general downward trend, even during the current oil and gas drilling boom in the Rockies.

Figure 1. Resource Extractive Industry Income in the Rocky Mountain Region

As the economies of rural communities in the West diversify, the framework for making public land management decisions must also evolve. Merely counting jobs in resource extraction is not a sufficient way to measure the economic impact of public land management decisions. Many of these communities have diversified economies that

are no longer solely dependent on the export of fossil fuels or logs. Management plans for public lands need to account for all aspects of the economic and social systems of these communities, including recreation, tourism, and entrepreneurial businesses attracted to scenic locations, when evaluating alternatives.

There is a vast and growing body of research that indicates that the environmental amenities provided by public lands are an important economic driver in the rural West (Rudzitis and Johansen 1989; Johnson and Rasker 1993, 1995; Rasker 1994; Power 1995, 1996; Duffy-Deno 1998; Rudzitis 1999; Rasker et al. 2004; Holmes and Hecox 2004). In a letter to the President and the Governors of the western states, economists from universities and other organizations throughout the United States pointed out that, "The West's natural environment is, arguably, its greatest long-run economic strength" (Whitelaw et al. 2003).

The western United States is growing at a rate faster than any other region (U.S. Census Bureau 2001), and, counter to the norm, population growth has preceded employment growth in the rural West (Vias 1999), indicating that people migrate to the region for its amenity resources. Furthermore, counties with high levels of natural amenities (such as varied topography, access to water bodies, and a pleasant climate) are more likely to experience higher growth than those counties with fewer such amenities (McGranahan 1999). Along with that growth comes demographic change. As Shumway and Otterstrom (2001) point out, "Population change represents more than a simple redistribution of people; it is an indicator and, in many instances an instigator, of a wide range of economic, social, cultural, political/policy, and environmental changes." As more people move from urban areas to rural communities they bring with them expectations about how local public lands ought to be managed. Changing community values must be accounted for in land management planning.

Management plans for the public lands in the West must consider the increasing importance of industries and economic sectors that rely on these public lands, but not necessarily on the extraction of natural resources. As the population of the entire country grows, the presence of undeveloped lands becomes more and more important. Indeed, much recent research has concluded that the presence of protected public lands strengthen western rural economies by meeting growing needs for clean water, wildlife habitat and recreation opportunities (Power 1995, 1996; Rasker 1994; Rasker et al. 2004; Rudzitis 1999; Rudzitis and Johansen 1989; Johnson and Rasker 1993, 1995; Whitelaw et al. 2004).

IV. KEY ECONOMIC INDICATORS OF THE WEST'S ECONOMY

The West's economy is characterized by many indicators that must be considered in the economic analyses performed by land management agencies; we have selected only a few to focus on in this brief. These include the growing importance of non-labor income from investments and retirement; increasing employment in high technology, knowledge-based, and service industries; the important role that recreation and tourism plays in providing jobs and income; and the rise of small businesses and other entrepreneurial endeavors. Other features of the western economy include the decline in extractive industries, the increase in public awareness and appreciation of the environmental and recreation amenities of their home counties, and the diversification of rural economies. This section describes a concise set of indicators that land use planners should examine as part of the description of the socio-economic profile of an area, and presents example data from the Rocky Mountain states for each indicator.

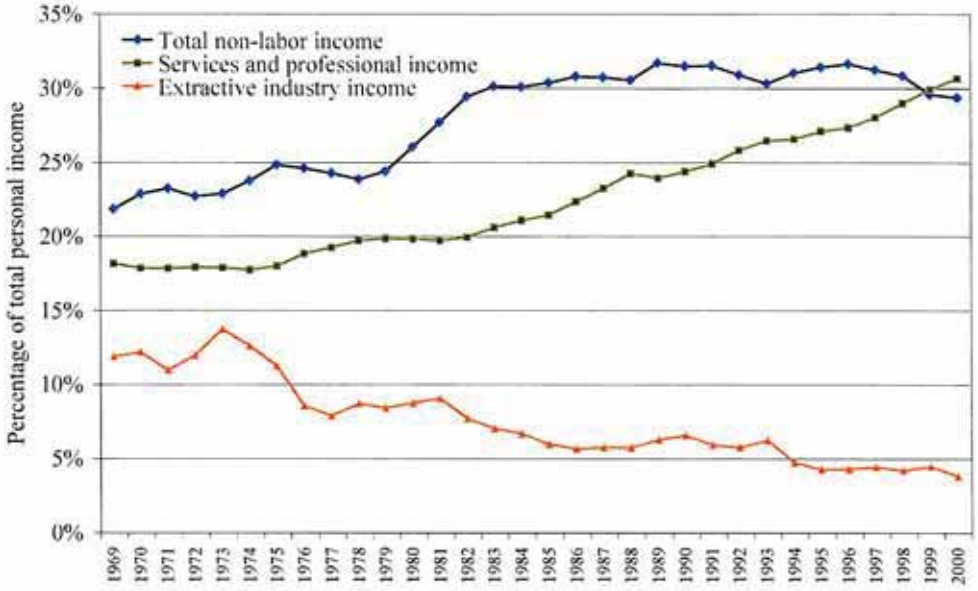
A. Non-labor income

A complete analysis of regional economic trends should include an analysis of total personal income, including all sources of income, rather than relying solely on employment. A full accounting of income is necessary to an understanding of the important role that non-labor income — such as retirement income, interest payments, rents, and profits — plays in the regional economy. Investment and retirement income makes up nearly one-quarter of total personal income in the Rockies, which would make it the top "industry" in the region. An economic impact analysis that excludes this income is inadequate and misleading.

Researchers have found that areas with high levels of natural amenities attract residents, many of whom rely on non-traditional sources of income (Duffy-Deno 1998, Nelson 1999, McGranahan 1999, Rudzitis 1999, Shumway and Otterstrom 2001, Lorah and Southwick 2003). When an investor living in a community receives dividends on his or her investments, that money represents an influx of income for the local community. The same thing is true of a retiree's

income. Due to the high levels of natural amenities in the coastal and mountain regions of the West, these non-labor sources of income are concentrated in those areas (Nelson 1999).

An influx of retirees in those rural communities has been shown to have positive effects on both income and employment (Deller 1995), with non-labor income fueling increases in income and employment for many other sectors including health, financial and real estate services. Figure 2 shows the trend in total personal income for the five-state Rocky Mountain region. Service sector income has been rising in recent years while extractive industry income has fallen. Non-labor income makes up the largest proportion of total personal income.



Source: Regional Economic Information System, Bureau of Economic Analysis, US Department of Commerce
Extractive industries: "Farm proprietors' income," "Farm earnings," "Agricultural services, forestry, fishing," "Mining," "Lumber and wood products," and "Paper and allied products"
Service and professional: "Services," "Eating and drinking places," and "Finance, insurance, and real estate"
Note: The figure is based on SIC data for 1969-2000 in order to show the long-term trend. While not explicitly compatible, NAICS data for 2001-2003 show similar trends for non-labor, service and professional, and extractive industry income

Figure 2. Total Personal Income in the Rocky Mountains

Table 2. Non-labor income as a percentage of total personal income (2003)

	Colorado	Montana	New Mexico	Utah	Wyoming	Rocky Mountain Region
Investment income [a]	17%	19%	15%	15%	23%	16%
Retirement income [b]	6%	11%	10%	7%	9%	7%
Income support [c]	3%	4%	7%	3%	3%	4%
Other [d]	0.7%	1.1%	1.4%	1.1%	0.8%	0.9%
All non-labor income	26%	35%	33%	26%	36%	28%

Source: Regional Economic Information System, Bureau of Economic Analysis (http://www.bea.doc.gov)

[a] Dividends, interest, and rent

[b] Includes veterans' benefits, military benefits, and Medicare

[c] Income Maintenance, Supplemental Security Income, Family Assistance, Food Stamps, Medicaid, Unemployment

[d] Includes federal education and training assistance, settlements between individuals and businesses and transfer payments from non-profit institutions

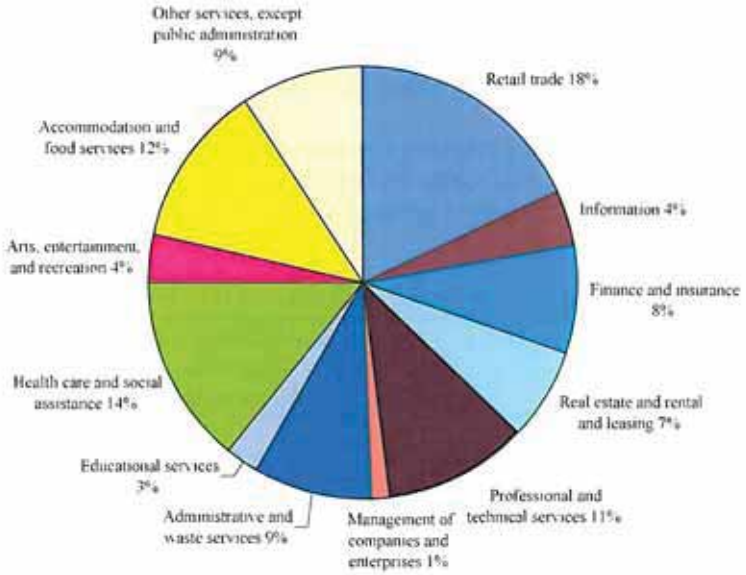
It should be noted that non-labor income also includes income support payments such as Medicaid, welfare and unemployment. However this category is consistently a small portion of total non-labor income and therefore a small portion of total personal income. Income support is less than 4 percent of total personal income and only 14 percent of non-labor income in the Rockies. It is important for a complete analysis of non-labor income to make a distinction between income support and other forms of non-labor income. Table 2 shows non-labor income, broken into its components as a percentage of total personal income for the five Rocky Mountain States. Investment and retirement income is the largest portion of non-labor income for each state, while income support reflects a much smaller portion.

A complete analysis of an area's economy must consider non-labor income, and a thorough evaluation of land management alternatives must consider the impacts of each alternative on non-labor income.

B. Knowledge-Based, Service Sector and Other Non-Recreation Businesses

Bennett and McBeth (1998) cite the emergence of a trend toward increasing western rural populations as early as the 1970s and state that this trend was partly motivated by the high quality of life in these areas. Johnson (2001) points out the importance of technology in this transition. He credits the advancement of technology with both the downward trend in extractive employment (where improved technology results in reduced labor requirements) and the potential (currently being realized in many communities) for economic growth and stability. Johnson points out that improving technology, especially in information and communication, also mitigates the constraints imposed by remoteness and permits employment in knowledge-based and service industries previously unavailable for rural residents.

Many of the counties in the Rocky Mountain West with economies that are characterized by a predominance of service industries have the highest incomes (Shumway and Otterstrom 2001). Over the past quarter-century, the U.S. economy has seen a shift from extractive and primary manufacturing industries to service oriented businesses. A common misconception about the service sector is that it includes only low paying jobs. This is not the case. The service sector in the West includes several high-paying industries, many of which are linked closely with the increase in non-labor income. Employment and income in the health care services increase as the number of retirees in an area increases. As people with investment income move into a region, the demand for financial, insurance, and real-estate service also increases.



Source: Regional Economic Information System, Bureau of Economic Analysis (http://www.bea.doc.gov)

Figure 3. Service and Professional Employment in the Rocky Mountains (2003)

The service sector includes occupations and industries that are classified as "knowledge based," defined by Henderson and Abraham (2004):

> "Knowledge-based activities emerge from an intangible resource that enables workers to use existing facts and understandings to generate new ideas. These ideas produce innovations that lead to increased productivity, new products and services, and economic growth."

Knowledge-based occupations have grown nationwide since 1980, with growth in the Rocky Mountain region being among the highest (Henderson and Abraham 2004). Local amenities that enhance quality of life are among the factors correlated with this growth. Other factors contributing to the growth of knowledge-based occupations are a high quality workforce, colleges and universities, infrastructure in the area, and the size and diversity of the local economy. These factors are likely to be interrelated and in many cases dependent on the quality of the environment and the availability of public lands, as cities and counties in the region leverage scenic amenities to attract high quality workers and knowledge-based industries. Other research confirms the role that amenities, including environmental and recreational amenities, play in attracting businesses to locations in the rural Rocky Mountain West (Whitelaw and Niemi 1989; Johnson and Rasker 1993, 1995). The most recent income data available from the Bureau of Economic Analysis (BEA) include a category called "information," which captures a good deal of the new knowledge-based industry. Land management decision makers should take advantage of these expanded industry classification categories when analyzing the potential impacts of public land management on the diverse economies of western counties.

A complete analysis of an area's economy must take into account the growth in income and employment in the service and professional sectors, and consider the impacts of each alternative on those sectors.

C. Recreation & Tourism

Many rural communities in the Rocky Mountain region have experienced firsthand the surge in demand for recreation experiences outdoors, especially on federal public lands. Moab, Utah is a good example. This town was once a dying mining center and is now a top destination for recreation seekers of all sorts. Other towns around the West have seen an upswing in migration and economic health as they become "discovered" by recreationists (Rasker, et al. 2003, 2004; Holmes and Hecox 2004).

A 2005 report by the Outdoor Industry Association estimates that 159 million Americans participate in outdoor recreation each year. A 2002 study by the same organization estimates annual spending on outdoor recreation at $18 billion. The public lands provide much of the open space that makes this important economic activity possible.

In 2000, the Forest Service estimated the economic impacts of their program areas. These estimates account for the impact a range of activities exerts on both income and employment. Recreation and protection programs account for a much greater economic impact than do extractive programs (Alward et al. 2003).

Table 3. Economic Significance of Forest Service Program Activities (for 1999)

	Percentage of Total Value Added (GDP)	Percentage of Total Income	Percentage of Total Wages	Percentage of Total Jobs
Recreation and Landscape Protection *Recreation, Heritage & Wilderness; Wildlife, Fish & Rare Plants; Watershed & Air Mgt; Ecosystem Mgt. Coord.; Access & Travel Mgt.*	70%	69%	71%	76%
Extraction of Commercial Resources *Range Mgt.; Forest Mgt.; Minerals & Geology Mgt.*	22%	22%	20%	17%
Other *Lands & Realty Mgt.; Fire & Aviation Mgt.; Law Enforcement; Facilities Mgt., General Admin.; S&P Forestry; R&D*	9%	9%	8%	7%

Source: Alward et al. 2003.

Quality hunting and fishing opportunities require wildlife habitat, which generally means large areas of open land. As the population grows, these are increasingly found only on the federal and other public lands. Pickton and Sikorowski (2004) estimate that the total economic impact of hunting, fishing, and wildlife-watching in Colorado at over $1.8 billion, with corresponding employment at 33,000 full-time jobs. An April 2004 report from the Center for the Study of Rural America calls wildlife recreation "rural America's newest billion-dollar industry" (Henderson 2004), with wildlife-related activities boosting tourism, spurring business growth and contributing to increased property values. The U.S. Fish and Wildlife Service and the Census Bureau jointly track participation and expenditures on wildlife-related recreation. Nationwide these activities generate $108 billion for local economies. Much of these expenditures are in the Rocky Mountain West, with hunters, anglers, and wildlife watchers spending nearly $6 billion in the five-state region alone in 2001 (U.S. FWS and U.S. Census Bureau 2001). Table 4 presents the participation in and expenditures on wildlife recreation for Colorado, Montana, New Mexico, Utah and Wyoming.

Table 4. Participation and expenditures from hunting, fishing, and wildlife-associated recreation in the Rocky Mountains (2001)

	Participation	Expenditures
Colorado	2.1 million	$2 billion
Montana	871,000	$943 million
New Mexico	884,000	$1 billion
Utah	1.1 million	$1.4 billion
Wyoming	662,000	$634 million

Source: U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2001.

A complete analysis of an area's economy must present data and analysis that fully account for the important role that tourism, recreation, hunting, and fishing play in ensuring a sustainable and diversified economy for rural western communities.

D. Entrepreneurs

All of the indicators previously discussed are related to the increasing entrepreneurial activity being experienced West-wide. Entrepreneurs in high technology and knowledge-based industries can often choose their location, and are likely to choose high-amenity locations (Rasker and Glick 1994, Snepenger et al. 1995, Johnson and Rasker 1995, Beyers and Lindahl 1996, Rasker and Hansen 2000, Low 2004, Henderson and Abraham 2004). Recreation- and tourism-oriented businesses are often founded by footloose entrepreneurs seeking to live and work in places rich in amenities. Retirees and others relying on investment income also choose amenity-rich locations that include certain businesses and services. These new migrants bring with them entrepreneurial opportunities for those who can provide the services they seek.

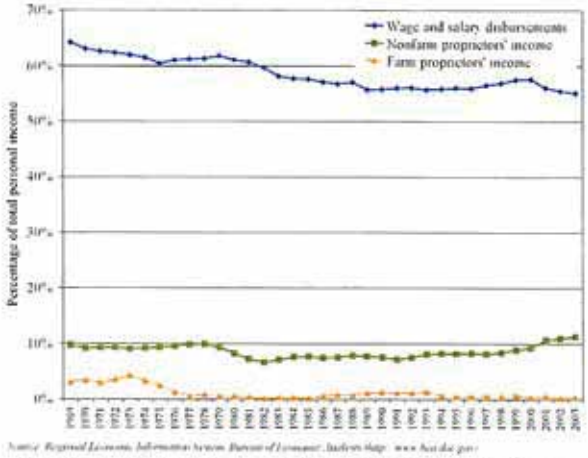


Figure 4. Rocky Mountain Personal Income by Type

Figure 4 shows personal income by type for the Rocky Mountain region. While wage and salary income is still the largest portion of total personal income, non-farm proprietors' income has shown an upturn in recent years.

As the proportion of total personal income from non-farm proprietors grows, implications for rural communities and for management of the public lands that surround them also grows. As Low (2004) points out: "Entrepreneurs create local jobs, wealth, and growth — and are themselves innovative users of other regional assets and resources." Furthermore, Low notes: "Entrepreneurs bolster a region's quality of life while promoting economic prosperity. Research has found a strong correlation between entrepreneurship and long-term regional employment growth."

Beyers and Lindahl (1996) specifically examine businesses which provide "producer services" and find these businesses are expanding rapidly in rural areas, and that most of them conduct much of their business interregionally or even internationally, bringing outside income into the rural region where they are located. These researchers also found that the decision to locate in rural areas is mostly for quality-of-life reasons, providing further evidence of the importance of such factors to local economies and the need to examine public land management activities and the potential impacts on quality of life.

A complete analysis of an area's economy must take into account the growing role of entrepreneurial businesses, and consider the impacts of each alternative on those businesses attracted by the environmental amenities provided by public lands in those communities.

E. The Role of Protected Public Lands

More and more people in the West, and all over the US, are able to choose where they live and work. Technology makes it easier for professionals to "telework" using electronic communications. Many businesses are able to conduct national or international commerce from any location they choose. Other entrepreneurs simple choose to live in a particular place and build a business in response to local needs. Retirees and others who collect non-labor income are not tied by a job to a specific location. All of these people seek an attractive place to live. More and more, as development pressures increase, public lands become a backdrop or setting which contributes to or even creates the amenities on which a community's economy will thrive and grow. Research supports the assertion that protected public lands contribute to rural economic health (Rudzitis and Johansen 1989, Rudzitis and Johnson 2000, Rasker et al. 2004).

Local communities with protected wildlands reap measurable benefits in terms of employment and personal income. For instance, the Sonoran Institute (Sonoran Institute 2004b) has found that protected lands have the greatest influence on economic growth in rural isolated counties that lack easy access to larger markets. From 1970 to 2000, real per capita income in isolated rural counties with protected land grew more than 60 percent faster than isolated counties without any protected lands.

These findings confirm earlier research showing that wilderness is in fact beneficial for local economies. Residents of counties with wilderness cite the presence of that wilderness as an important reason why they moved to the county, and long-term residents cite it as a reason they stay. Recent survey results also indicate that many firms decide to locate or stay in the West because of scenic amenities and wildlife-based recreation, both of which are strongly supported by wilderness areas (Morton 2000).

As noted by Freudenburg and Gramling (1994):

> "…it needs to be recognized as a serious empirical possibility that the future economic hope for resource-dependent communities of...the United States could have less to do with the consumption of natural resources than with their preservation."

This sentiment is reiterated by Deller et al. (2001):

> "Rural areas endowed with key natural resource amenities can manage those resources to capture growth more effectively. This may entail expansion beyond policies that have historically been focused on extraction of the resource base."

Resource managers, economic planners and community leaders must become aware of this potential. We therefore request that the NEPA process fully address the economic importance to local communities of protecting public wildlands from resource extraction.

V. SOURCES OF DATA

This section presents selected sources of economic, demographic, and recreation data.

A. Economic and Demographic Data

Data are available for several economic indicators by county from the U.S. Department of Commerce, Bureau of Economic Analysis and the U.S. Department of Labor, Bureau of Labor Statistics. The U.S. Census Bureau also tracks economic trends along with demographic trends, most by county as well. Economic profiles showing these and other trends by state, county, or groups of counties are available from the Sonoran Institute's Economic Profile System.

Federal economic and demographic data sources:

- Bureau of Economic Analysis (Department of Commerce): http://www.bea.doc.gov
  - Date on income, farm income, transfer payments, and employment for states, counties, and regions. Annual data, 1969-2000 (Standard Industry Classification) and 2001-2003 (North American Industry Classification System)
- Bureau of Labor Statistics (Department of Labor): http://www.bls.gov
  - Data on income, wage and salary, employment, unemployment rates by industry, for counties, states, and regions. Monthly data, 1990-2005
- Census Bureau (U.S. Department of Commerce): http://www.census.gov
  - Data on population, demographics, business, and economics for states and counties
- The Sonoran Institute Economic Profile System: http://www.sonoran.org
  - Generates detailed economic profiles, including trends in employment and income, farm income, economic resilience, and demographics for states, counties, or groups of counties. The companion, Economic Profile System — Community, will generate profiles to reflect just the rural or urban areas of a county.
- The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, Census Bureau): http://www.census.gov/prod/www/abs/fishing.html
  - Data at the state level on participation in and expenditures for wildlife-associated recreation

Selected state economic and demographic data sources:

- Colorado Economic and Demographic Information System: http://www.dola.state.co.us/is/cedishom.htm
- Montana Census and Economic Information Center (CEIC): http://ceic.commerce.state.mt.us/
- New Mexico Labor Market Information: http://www.dol.state.nm.us/dol_lmif.html
- New Mexico Economic Development Data Center: http://ww1.edd.state.nm.us/index.php?/data/C31/
- Utah Governor's Office of Planning and Development, Demographic and Economic Analysis: http://www.governor.utah.gov/dea/
- Wyoming Department of Administration and Information, Economic Analysis Division: http://eadiv.state.wy.us/

B. Recreation Data

Data on recreation use in the area where a land management plan is being developed is critical to making an informed decision. Surveys of users at recreation areas can be utilized to obtain information on the levels and types of

recreation use. Information on users' expenditures in the area is also important to learn the overall impact of public lands recreation. Federal land management agencies collect some data on recreation use of public lands. The Bureau of Land Management's Recreation Information Management System (RIMS) and the USDA Forests Service's National Visitor Use Monitoring System (NVUMS) are two examples.

Other information may be obtained through surveys of local residents, recreation visitors and through using existing data on the recreation and tourism revenues to local businesses, and the value of these activities to participants. The lack of complete visitation data does not justify ignoring the jobs and income from recreation. Furthermore, the Data Quality Act requires use of the best available, reliable data on all impacts and affected sectors of the economy.

The National Survey on Hunting, Fishing and Wildlife-Associated Recreation (noted above) is also a source of state-wide data on participation in wildlife recreation that should be used to supplement more specific studies for the location in question. State agencies are also a source of data on fishing and hunting and other wildlife-associated recreation.

Colorado Division of Wildlife: http://wildlife.state.co.us/index.asp
Montana Fish, Wildlife, and Parks: http://fwp.state.mt.us/default.html
New Mexico Game and Fish: http://www.wildlife.state.nm.us/index.htm
Utah Division of Wildlife Resources: http://wildlife.utah.gov/index.php
Wyoming Game and Fish: http://gf.state.wy.us/

C. Data Gaps and Other Issues

Land managers may encounter gaps in county- or state-level economic data or may notice that data series are not continuous. These are not, however, obstacles to doing a thorough and comprehensive analysis of the trends in the economies of the local area.

1. Disclosure Gaps

Some data gaps are due to disclosure restrictions. The Bureau of Economic Analysis and the Bureau of Labor Statistics will suppress data in cases where disclosing it may reveal private information about individuals. For example, if only one business represents a specific industry in a given area, any data on employment and/or income in that industry will not be publicly disclosed since it may make it possible to identify an individual's or business' private information. Disclosure suppression is more likely to be a problem in counties with small populations. The Sonoran Institute suggests several potential techniques to address the issue of data gaps due to disclosure issues. The Economic Profile System will also automatically estimate the data gaps for major industry categories. These are described in detail in the User's Manual for the EPS (Sonoran Institute 2004b.)

2. Other Data Gaps

BEA and Bureau of Labor Statistics (BLS) data are sometimes not available for certain industries and/or certain years. Other data are suppressed, but are identified as falling within a range of values. Data gaps where an "L" appears instead of a number are described as follows:

Less than 10 jobs, but the estimates for this item are included in the totals, or
Less than $50,000 (for income data), but the estimates for this item are included in the totals

3. Industry Classification Using SIC and NAICS

Income and employment data from the Bureau of Economic Analysis and the Bureau of Labor Statistics for 1969-2000 are classified according to the Standard Industry Classification system (SIC), while the most recent data (2001 and forward) are classified by the North American Industry Classification System (NAICS). NAICS was developed jointly by the U.S., Canada, and Mexico in order to make statistics comparable across all three countries.

The NAICS provides greater detail for the service and professional sectors which are of growing importance in the rural West, and indeed all over the country. This classification scheme also includes some emerging industries such as "information" which includes the growing Internet and information phenomenon. The Bureau of Economic

Analysis' Regional Economic Information System (REIS) uses SIC to classify industries and the Sonoran Institute's EPS system uses SIC data from the REIS in order to show trend analyses, along with NAICS data.

VI. RECOMMENDED METHODS FOR ANALYSIS

In general, it is inappropriate to examine a region's economy solely as a single point in time because economies are dynamic. To the extent that data are available, the economic profile of an area should be developed based on the trends in key economic indicators. This can help guide resource management by showing the likely future situation in an area and can point out periods of economic downturn. It may be instructive to look at other variables during these periods to see if there are correlations between land management activities and economic activity.

Looking at the changes in employment and income (including non-labor income) is important to understanding the overall direction in which an area's economy is moving. Trend analysis will show long-term patterns in income and employment that may be masked when looking at only a point in time. Data on employment and income are available from 1969-2000 from the BEA under the SIC system. The BEA changed to the NAICS in 2001, and reconstructed NAICS data for years prior to 2001 are not yet available. However, one can certainly look at a general picture of the economy over time by using both sets of data. This analysis should be applied to all the segments of the economy to see the long-term trends in both extractive and other industries along with non-labor income.

A lack of data on recreation activities on public lands should not be an excuse to avoid analysis of potential impacts of public land management decisions on the recreation sector. Several examples of research on recreation use, values to participants, and expenditures are available (a very limited sample includes: Fix and Loomis 1997, Chakraborty and Keith 2004, Cordell and Tarrant 2002, Kaval and Loomis 2003). Rosenberger and Loomis (2001) present a detailed bibliography of recreation valuation studies and present methods by which analysts can transfer estimates of the value of recreation in one area to other similar areas. Of course, the best way to truly understand the value of recreation in an area is to conduct a survey specifically focused on that area. At a minimum, such a survey should collect information on recreation visitation and expenditures. An estimate of the economic impacts of recreation can be made by multiplying the total number of recreation visitors in an area by the estimated expenditures per visitor day. These data should be collected and analyzed as part of a comprehensive analysis of the socio-economic impacts of land management.

VII. RECOMMENDED ANALYSES

The preceding sections of this brief have presented the key indicators that must be included in a socio-economic impact analysis, identified data sources for conducting that analysis, and provided methods for completing an analysis that more accurately reflects the West's economy. In making land-use decisions, federal agencies have an obligation under NEPA to take a "hard look" at the environmental consequences of a proposed action, and the requisite analysis "must be appropriate to the action in question." [2] The impacts and effects of a proposed action, such as oil and gas development, that federal agencies are required to assess include: "ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative." [3] Under the Data Quality Act, federal agencies are required to use information that is of high quality and that is objective, useful, and verifiable by others. [4] The agency must also use "sound statistical and research" methods. [5]

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[2] 42 U.S.C. § 4321 et seq.; *Metcalf v. Daley*, 214 F.3d 1135, 1151 (9th Cir. 2000); *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 348 (1989).

[3] 40 C.F.R. § 1508.8.

[4] Treasury and General Government Appropriations Act for Fiscal Year 2001, Pub.L.No. 106-554, § 515. *See also*, Office of Management and Budget "Information Quality Guidelines," available at http://www.whitehouse.gov/omb/inforeg/iqg_oct2002.pdf and individual "Agency Information Quality Guidelines," available at http:/www.whitehouse.gov/omb/inforeg/agency_info_quality_links.html.

[5] *Ibid.*

Federal agencies cannot evaluate the consequences of proposed decisions or determine how best to avoid or mitigate negative impacts without adequate data and analysis. NEPA's hard look at environmental consequences must be based on "accurate scientific information" of "high quality."[6] Essentially, NEPA "ensures that the agency, in reaching its decision, will have available and will carefully consider detailed information concerning significant environmental impacts."[7] The Data Quality Act and the agencies' interpreting guidance expand on this obligation, requiring that influential information or decision-making input be based on "best available science and supporting studies conducted in accordance with sound and objective scientific practices."[8]

Through the application of the methodology, key indicators and data sources we have provided, federal agencies can better fulfill their obligations to evaluate the direct, indirect, and cumulative impacts of various alternative decisions. In this section, we have provided both general recommendations on the scope of the socio-economic impact analysis that should occur and specific inquiries to be made in this analysis. Again we note that completion of the socio-economic analyses outlined in this brief is necessary but not sufficient to fully evaluate a land management decision. A thorough benefit-cost analysis is also required and expected.

We formally request that the NEPA analysis fully reflect and account for the following scoping comments:

A. The socio-economic analysis should include an analysis, graphs and discussion of historic personal income trends — including non-labor sources of income.

The analysis of regional economic impacts must include an analysis of all sources of income, including non-labor income. A full accounting of all sources of income is necessary to understand the important role that retirement and investment income — as well as other sources of non-labor income, such as interest payments, rents, and profits — play in the regional economy. An economic impact analysis that excludes non-labor income is inadequate and misleading.

- **Specific Requests and Requirements for examining the Total Personal Income and the Importance of Non-Labor Income as Part of the NEPA Process:**

For all counties in the planning area, please show the role of non-labor income in the area's economy.

Show the percentage of current total personal income that is non-labor income (excluding income support).

Analyze and discuss the role that retirement and investment income currently plays in the area's economy, including the spillover effects of non-labor income on businesses in the area.

Analyze and discuss the role that amenities, including recreation opportunities and environmental quality, currently play in attracting and retaining non-labor income to the area.

Analyze and discuss the potential impacts that public land management alternatives will have on the level and trend of investment and retirement income in the area.

Show the trend in non-labor income (again excluding income support) as a percentage of total personal income.

[6] 40 C.F.R. § 1500.1(b).
[7] *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989).
[8] Treasury and General Government Appropriations Act for Fiscal Year 2001, Pub.L.No. 106-554, § 515. *See also*, Office of Management and Budget "Information Quality Guidelines," available at http://www.whitehouse.gov/omb/inforeg/iqg_oct2002.pdf and individual "Agency Information Quality Guidelines," available at http://www.whitehouse.gov/omb/inforeg/agency_info_quality_links.html.

B. The socio-economic analysis must include an analysis and discussion on the indirect role public lands play in the regional economy in attracting knowledge-based businesses, service sector business, recreation and tourism businesses, and other entrepreneurs.

Public wildlands often define the character of an area and are an important component of the quality of life for local residents and future generations. Their protection enables the customs and culture of western communities to continue. The socio-economic analysis also must account for these economic benefits.

A growing number of economists are recognizing that protecting the quality of the natural environment is key in attracting new residents and businesses, and that therefore the environment is the engine propelling the regional economy. A letter to President Bush from 100 economists concludes, "The West's natural environment is, arguably, its greatest, long-run economic strength… A community's ability to retain and attract workers and firms now drives its prosperity. But if a community's natural environment is degraded, it has greater difficult retaining and attracting workers and firms" (Whitelaw et. al, 2003). Given these findings, we request that, as part of the economic impact analysis of management alternatives, the socio-economic analysis fully consider the indirect role of public lands in attracting and retaining non-recreational businesses and retirees and encouraging entrepreneurial efforts.

- **Specific Requests and Requirements for Examining the Role of Protected Public Lands in the Local Economy as Part of the NEPA Process:**

For all counties in the planning area, please show the role of various industries in the area's economy.

- Show the current distribution of employment and income by industry (for each industry, show employment as a percentage of total jobs and income as a percentage of total personal income).
  - Discuss the relative importance of each industry.
  - Analyze and discuss the impacts that public land management alternatives will have on non-extractive industries if extractive activities are accelerated on public lands in the area.
- Show a complete analysis of the segments of service and professional employment and income for the area.
  - Analyze and discuss the potential impacts of land management alternatives on these sectors of the economy.
- Show trends in employment and income by industry, including a detailed examination of the service and professional sectors.
  - Discuss the level of diversity in the region's economy. Discuss trends in income and employment that have led to the current mix of industries
  - Analyze and discuss the potential impacts of public lands management alternatives on the overall makeup of the economy of the area.
- Show trends in non-farm proprietor's income as a percentage of total personal income for the area.
  - Collect data on the various sectors that make up non-farm proprietors. Analyze the sectors where entrepreneurship is growing.
  - Analyze and discuss the factors that have attracted new businesses to the area.
  - Analyze and discuss the potential impacts that public land management alternatives will have on these sectors and the ability of proprietors to start and grow businesses.

C. The socio-economic analysis must account for the economic importance of the recreation, hunting, and fishing that occurs on public land.

The recreation opportunities provided by wilderness-quality lands also yield direct economic benefits to local communities. The socio-economic analysis must include an analysis of the income and jobs associated with recreation, hunting and fishing from each alternative.

- **Specific Requests and Requirements for Examining the Economic Importance of Recreation, Hunting and Fishing on Public Lands as Part of the NEPA Process:**

For all counties in the planning area, show the role of recreation, hunting and fishing in the area's economy.

Collect data on participation in all recreation activities (hunting, fishing, hiking, camping, backpacking, biking, skiing, wildlife watching, boating, ORV use, etc.)

Collect data on expenditures by recreation visitors in the region.

Analyze the economic impact of hunters' and anglers' expenditures on area businesses and local economies.

Analyze the economic impact of other recreationists' expenditures on area businesses and local economies.

Show the impact of lodging taxes, sales taxes, and property taxes in the local economy.

Analyze and discuss the impact of public land management alternatives on recreation, hunting, and fishing businesses.

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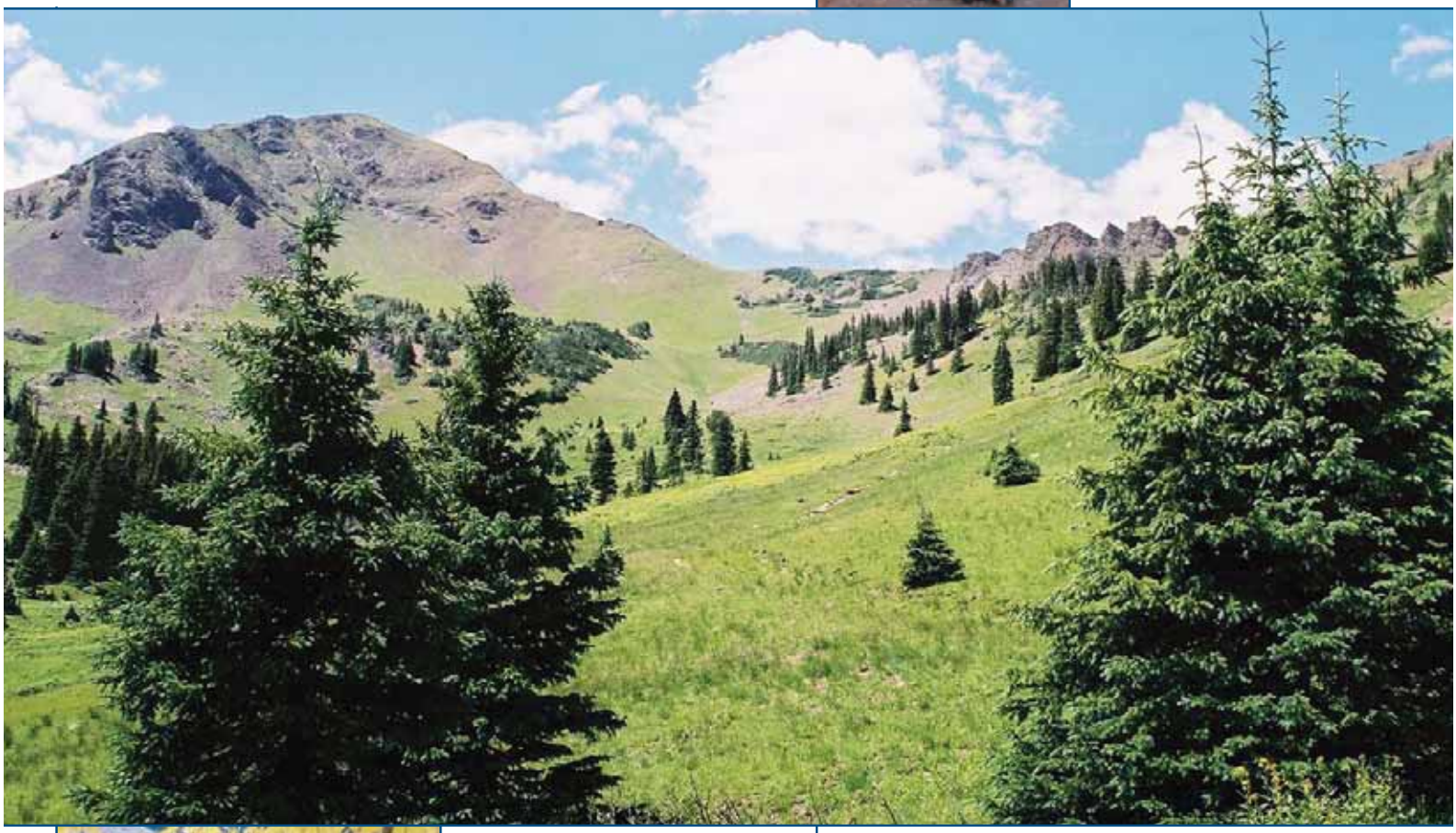
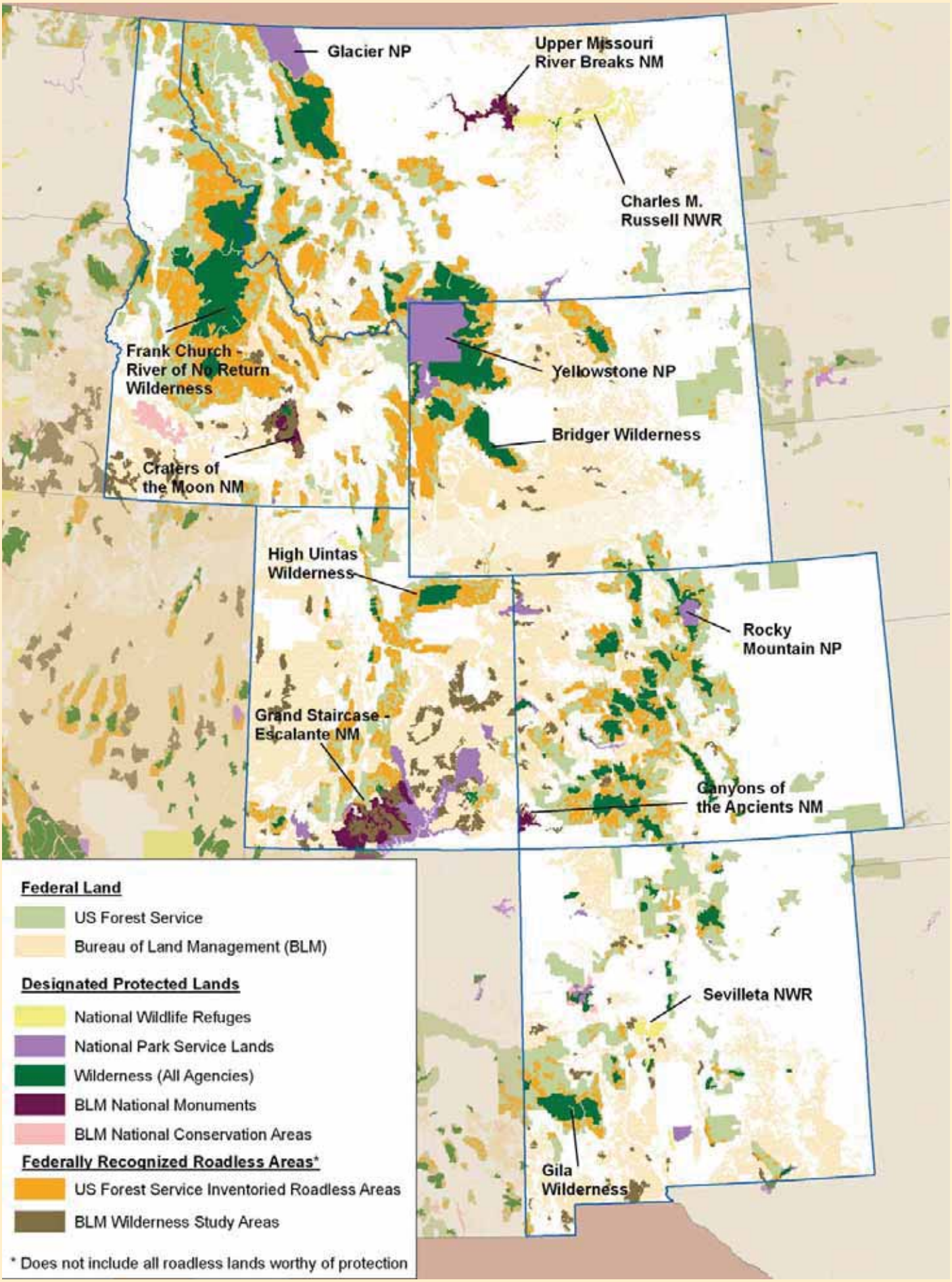


NATURAL DIVIDENDS

Wildland Protection and the Changing Economy of the Rocky Mountain West

MICHELLE HAEFELE, PH.D. • PETE MORTON, PH.D. • NADA CULVER


Glacier NP
Upper Missouri River Breaks NM
Charles M. Russell NWR
Frank Church - River of No Return Wilderness
Yellowstone NP
Bridger Wilderness
Craters of the Moon NM
High Uintas Wilderness
Rocky Mountain NP
Grand Staircase - Escalante NM
Canyons of the Ancients NM
Sevilleta NWR
Gila Wilderness
Federal Land
US Forest Service
Bureau of Land Management (BLM)
Designated Protected Lands
National Wildlife Refuges
National Park Service Lands
Wilderness (All Agencies)
BLM National Monuments
BLM National Conservation Areas
Federally Recognized Roadless Areas*
US Forest Service Inventoried Roadless Areas
BLM Wilderness Study Areas
* Does not include all roadless lands worthy of protection

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About the cover photos (from top):
Young hikers in Grand Staircase-Escalante National Monument, Utah.

Alpine vista, Rocky Mountain National Park, Colorado.

Every year visitors enjoy the changing colors of the Rockies' quaking aspen.

Photo this page:
A hiker enjoying Cold Spring Mountain, a Citizen-Proposed Wilderness Area in northwestern Colorado.

About The Wilderness Society

Our Mission

The Wilderness Society is a national conservation group dedicated to science-based advocacy. For more than 70 years, our group has worked to conserve America's unparalleled wildland heritage and ensure the wise and balanced management of our public lands legacy.

Headquartered in Washington, D.C., the Society also maintains regional offices throughout the country where our staff address on-the-ground conservation issues linked to local communities. Since spearheading passage of the seminal Wilderness Act in 1964, we have been a leading advocate for every major piece of Wilderness legislation enacted by Congress, work that is supported by an active membership of more than 200,000 committed conservationists. Our effectiveness stems from a team approach to conservation, which links our scientists, policy experts, and media specialists to thousands of grassroots activists—creating a potent force to promote change.

Building the case for land preservation with research and sound science is the key to successful environmental advocacy and policy work. Nearly a quarter century ago, The Wilderness Society helped pioneer strategies that incorporated expert economic and ecological analysis into conservation work. Today, through focused studies, state-of-the-art landscape analysis—and diligent legwork by our many partners who provide us with on-site data—our Ecology and Economics Research Department is able to serve the needs of the larger conservation community.

Legislators, on-the-ground resource managers, news reporters, our conservation partners, and—most importantly—the American people must have the facts if they are going to make informed decisions about the future of this nation's vanishing wildlands. The answers to the pressing legal, economic, social, and ecological questions now at issue are the stepping stones to that understanding and, ultimately, to achieving lasting protection for the irreplaceable lands and waters that sustain our lives and spirits.

Above: Rafting on the Yampa River through Dinosaur National Monument, Colorado. Americans spend nearly $300 billion annually on gear and services for non-motorized, outdoor recreation and generate an additional $430 billion in spill-over economic activity.

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We would like to express our deepest gratitude to The Aspenwood Foundation for its generous financial support for this report and of our conservation science program in the Northern Rockies.

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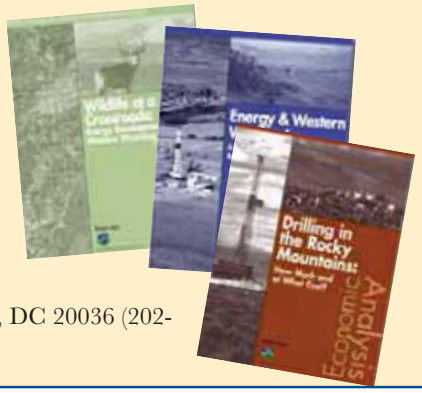
Heath Nero produced the map of the Rocky Mountain States' public lands. Dr. Susan Solarz helped guide this project through the initial planning and organization. She also provided invaluable help with the "faces" of the contemporary western economy, as did Chris Mehl, Melissa Kolwaite, Steve Smith and Suzanne Jones. Thanks also to the photographers who have allowed us to use their artwork and to the individuals and businesses featured throughout the report.

Finally, we would like to thank Dr. John Loomis of Colorado State University, and Dr. Ray Rasker and Ben Alexander of Headwaters Economics for their insightful peer reviews of early versions of this report.

This science report is one of a series that stems from conservation research studies conducted by The Wilderness Society's Ecology and Economics Research Department. Other reports in the series that focus on issues relevant to this report include:

- **Wildlife at a Crossroads:** Energy Development in Western Wyoming
- **Energy & Western Wildlands:** A GIS Analysis of Economically Recoverable Oil and Gas
- **Drilling in the Rocky Mountains:** How Much and at What Cost?



The entire series is available on The Wilderness Society's web site <www.wilderness.org> and from The Wilderness Society, Communications Department, 1615 M Street, NW, Washington, DC 20036 (202-833-2300 or 1-800-THE-WILD).

Preface

The vast landscapes of the Rocky Mountain West—Colorado, Idaho, Montana, New Mexico, Utah and Wyoming—comprise one of the most unspoiled and fastest growing regions of the United States. New residents, drawn to the clean environment, open spaces and recreation opportunities offered by public land in the Rockies, have brought new money to rural communities and opened the door to high-paying occupations such as computer programmers, doctors, architects and financial advisors. Meanwhile, technology continues to liberate workers from urban settings, allowing them to choose places to live based on other quality-of-life concerns. "Footloose" entrepreneurs who migrate to areas rich in natural amenities have also infused rural economies with new vitality.

Contrary to a common misperception, the economy of the American West no longer depends solely on traditional resource-extractive industries. Mining, logging, oil and gas development, farming and ranching are waning in importance. Instead, economic health and sustainable growth often are tied to the protection of the region's abundant natural resources—a trend that will likely intensify in the coming years. Public lands, particularly protected lands which provide natural amenities and open spaces, are crucial to this economic equation.

At the same time, however, a frenzy of oil and gas development has taken hold with unchecked drilling eroding the quality of life in communities across the region. And as land managers consider the future of our western public lands, they frequently limit their analyses to the number of potential jobs created by fresh opportunities for resource extraction—an approach that is insufficient to predicting either the true economic costs of development or the long-term economic benefits of land protection.

The Wilderness Society's report, *Natural Dividends: Wildland Protection and the Changing Economy of the Rocky Mountain West*, examines these recent economic trends in detail. Synthesizing research on socioeconomic patterns, authors Dr. Michelle Haefele, Dr. Pete Morton and Nada Culver reveal the underlying connections between intact landscapes and growing community, regional and national economies.

Their study demonstrates how maintaining sustainable economies in many areas of the American West is directly linked to preserving natural resources and not exploiting them. While we believe resource-extractive industries, including oil and gas development, have their proper place in the region, some natural areas are simply inappropriate for these activities. Elsewhere, drilling and other types of extraction should only occur in the right location and with appropriate safeguards to protect the region's clean air and water, abundant wildlife and healthy communities.

By working to ensure that sound policies come forth from Washington, D.C., highlighting better alternatives and partnering with local citizens to help plan and monitor development projects, The Wilderness Society believes the Rocky Mountain West can enjoy the benefits of its many resources—and economic stability—without diminishing our nation's unparalleled natural treasures.

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Report Highlights

Above Right: Sunset skies over the Watchman, Zion National Park, Utah.

In this report, we synthesize recent research from economists and other scientists to provide a new picture of the economy of the contemporary Rocky Mountain West. This picture—broader and more accurate than the commonly held view that the region's economy is heavily dependent on resource extraction—recognizes the full value of protected public lands in ensuring sustainable economic development. Key findings and conclusions of the report include the following:

- **Protected public lands** produce measurable benefits in terms of employment and personal income for communities in the Rocky Mountains. Research has shown that real per capita income in isolated rural counties with protected land grows faster than in isolated counties without any protected lands.
- **Key economic indicators** that signal both a change in the West's economy and the health of specific communities include the rapidly expanding professional and service sectors, the increasingly important role that hunting, fishing, recreation and tourism play in the region, the rise of small businesses and other entrepreneurial endeavors, and the growing economic importance of retirees. All of these important economic sectors directly or indirectly benefit from protecting public wildlands, and yet are often ignored in public land management plans.
  - **The professional and service sector** has been growing in importance in the Rocky Mountains, accounting for over 30 percent of total personal income in 2005. This sector is very diverse, encompassing a wide range of both entry-level and high-wage occupations.
  - **Outdoor recreation, hunting, fishing and tourism** are important components of western economies. In 2006, hunters, anglers and wildlife watchers spent over $7 billion in the Rocky Mountain States, and non motorized outdoor recreation generated over $22 billion in economic activity.
  - **Entrepreneurs** bring jobs and income to the region and have been found to be an important indicator of an area's overall economic health and potential future prosperity.
  - **Retirees** and other residents with investment income represent one of the top "industries" in the region, with their income making up nearly one-quarter of total personal income in 2005. Retirees moving to the Rockies are attracted to the natural amenities provided by public land.
- **Extractive-industry income** in the Rocky Mountain economy has declined in the last 30 years, with oil and gas extraction accounting for just 1.3 percent of total personal income in the region in 2005.

This analysis shows how the West's people and communities have come to depend on the region's natural amenities—the clean air and water, quality outdoor recreation and hunting and fishing opportunities—suggesting a need for a more comprehensive approach to evaluating land management in the American West. Accordingly, we map out an approach that communities can use to encourage the sustainable growth of their economies without destroying the natural amenities on which those economies—and the community's quality of life—have come to depend. Our recommendations include:

- **Improve the socioeconomic impact analysis** in public land management plans by 1) incorporating an analysis of historic trends in jobs and personal income—including trends in retirement and other non-labor sources of income, 2) addressing the direct and indirect role protected public lands play in the regional economy, 3) accounting for the economic importance of the recreation, hunting and fishing that occurs on public land, 4) using estimates of economically recoverable quantities of oil and gas resources and 5) fully accounting for the hidden costs associated with oil and gas drilling.
- **Plan for amenity development** by developing strategies to ensure that the scale and pace of amenity development doesn't result in the same negative impacts as the current oil and gas drilling boom.
- **Slow the pace of oil and gas drilling** by implementing phased development of oil and natural gas resources.

We also include detailed information about many sources of economic and demographic data available at both the state and national level to aid in land management planning. We hope that this report will provide citizens, communities and decision makers with better information for balancing the extraction, recreation and amenity values of our public lands in the Rocky Mountains.

Introduction

With the economic diversification of the Rocky Mountain West over the past several decades, continued healthy economies in many of the region's communities depend on protecting natural resources rather than only on exploiting them. Resource extraction, such as the current boom in oil and gas drilling in the region, should only happen at the right pace and with appropriate safeguards to protect the West's wildlands, clean air and water, abundant wildlife and healthy communities.

Above: Frank Church-River of No Return Wilderness Area, in Idaho, designated in 1980, is one of the largest units of the National Wilderness Preservation System.

The western United States is known for its vast expanses of open space and remote wildlands, from broad prairies to sagebrush scrub, twisting canyons and rugged mountain peaks. Most of these wild landscapes are public lands, held in common ownership by all Americans—a status that has helped keep them wild in the face of considerable pressure to develop the natural resources found there. Protecting our western public wildlands[1] provides immense public benefits: recreation opportunities, wildlife habitat, scenic vistas, clean air and water and the preservation of a vital part of our American heritage (Morton 1999).

Yet if the story of the American West is one of unspoiled nature, it is also one of harnessing nature's bounty for human ends. Traditionally, the economy of the western United States has been perceived as one based on the extraction of the region's abundant natural resources—mining, logging, oil and gas drilling, farming and ranching. However, over the last 30 years the West's economy has become much more diversified (Bennett and McBeth 1998, Johnson 2001), with recreation, tourism, the professional and service sector, retirees and entrepreneurs making important contributions to the region's economic well-being. As we will discuss, the diversification and hence the health of our western economy benefit greatly from the protection of public wildlands.

This report provides a snapshot of the economic trends that have shaped the contemporary Rocky Mountain West (Colorado, Idaho, Montana, New Mexico, Utah and Wyoming), and describes key economic indicators associated with the growth and diversification of rural Rocky Mountain economies. Understanding these key economic indicators is particularly important in light of the frenzy of oil and gas development that is currently threatening public wildlands and natural amenities in the Rockies, and hence the competitive economic advantage of the region. Between 2001 and 2006, more than 17,000 gas and oil wells were drilled on

ABOVE: A hiker in the Santa Fe National Forest, New Mexico.

AT RIGHT: Black-chinned hummingbird.

public land in the Rockies, with thousands more wells drilled on private land in the region (Figure 1). In contrast, fewer than 9,500 wells were drilled between 1995 and 2000.

Oil and gas development is notorious for resulting in "boom and bust" cycles that can have devastating impacts on nearby communities. Research has indicated that an emphasis on resource extraction results in inherently unstable community economies (Fortmann et al. 1989, Freudenburg 1992, Freudenburg and Gramling 1994), often due to forces such as fluctuations in prices and changes in extraction technology, which are completely outside local control. The current drilling boom is a case in point. Rural communities have had little control over the pace or location of drilling—as the Bureau of Land Management (BLM) continues to ignore widespread local opposition to this development.

The current upsurge in oil and gas drilling is already having negative impacts on communities in the West (Limerick et al. 2002).[2] Recent news accounts document residents leaving areas where drilling has become such a nuisance that their quality of life and property values have declined (BBC Research and Consulting 2001). Other impacts include damage to rural roads, poaching in and around the gas fields and other crime—especially drug use (Jacquet 2005). The "hidden costs" from the current drilling boom also include air and water pollution, loss and fragmentation of critical wildlife habitat, decline in the quality of hunting and outdoor recreation in general and the potential damage to the region's natural amenities (Morton et al. 2004).

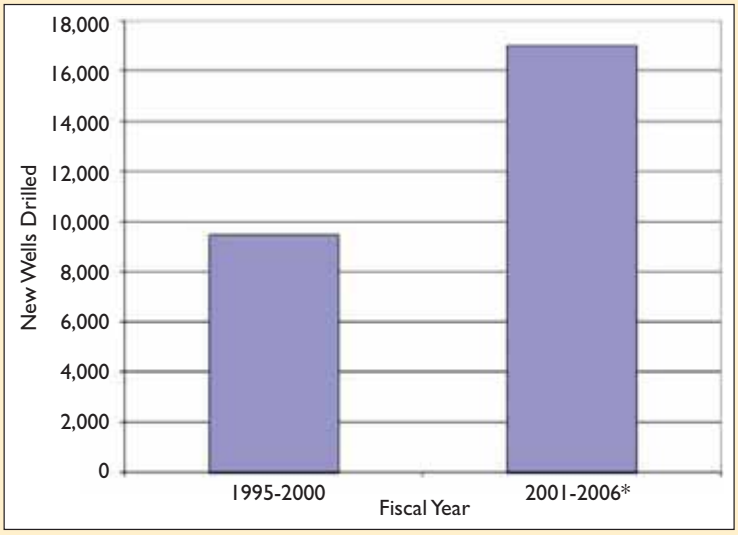
While oil and gas drilling, along with other natural resource development, can contribute to rural economies, the pace and scale of oil and gas booms can have negative impacts on many of the important economic sectors in the Rocky Mountains. Unfortunately, the fast-track energy plans prepared by the BLM to rush these drilling proposals out the door focus almost exclusively on oil and gas jobs, largely ignoring the contribution of other more important sectors of the local and regional economy. As this report makes clear, merely counting jobs in oil and gas drilling is not sufficient to predict the economic impact of proposals to increase this development. Communities and planners must also consider the increasing importance of industries and economic sectors that rely on protected wildlands, which could be harmed by the extraction of natural resources.

We begin our analysis with an overview of economic trends in the Rocky Mountains, before examining key economic indicators for measuring the health of western communities. We end our paper with recommendations for communities and public land managers.

FIGURE 1.

New Oil and Gas Wells Drilled on Public Lands in the Six-State Rocky Mountain Region

The Rocky Mountain States have become the major focus of natural gas drilling in the United States in recent years, putting at risk the quality of life and natural amenities that are key to sustainable economic growth for western communities.



* Due to an Automated Fluid Minerals Support System (AFMSS) shutdown in FY 2005, data are incomplete for this fiscal year. If these data were included the number of wells drilled in this period would be even greater.

Sources: U.S. Department of the Interior, Bureau of Land Management, Public Lands Statistics (FY 1995-1997) and Bureau of Land Management, AFMSS (FY 1998-2006).

Trends in Resource Extraction in the Rocky Mountains

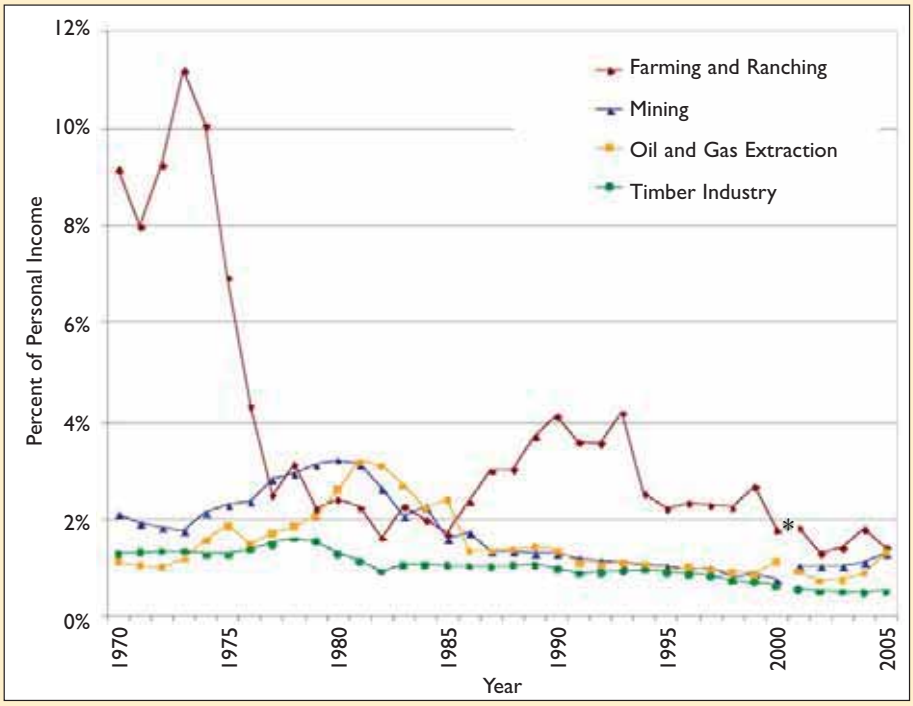
Despite widespread assumptions to the contrary, the timber, mining and oil and gas industries, while important locally to some communities, have never been large contributors to total personal income in the Rocky Mountain region (Figure 2).[3] In fact, the contribution of oil and gas extraction is roughly where it was 30 years ago—about 1.3 percent of total personal income in 2005, a remarkably small percentage given the current drilling boom. Meanwhile, the small contribution of the timber industry has also declined.

In 2005, the percentage of total personal income from extractive industries in the Rocky Mountain region ranged from just over 2 percent in Utah to approximately 14 percent in Wyoming (Table 1). As discussed, most western counties are not "resource dependent," but instead have developed diversified economies that also include recreation, retirees and the professional and service sector. A recent study examining the impact of public lands on economic well-being in 11 western states found that only 3 percent of western counties could be classified as resource-extraction dependent (Rasker et al. 2004). In fact, as we discuss in the following section, protected public lands are playing a more and more important role in the economies of most western communities, including many of the remaining resource-dependent counties.

FIGURE 2.

35-Year Trends in Personal Income from Agriculture and Resource-Extractive Industries in the Rocky Mountain Region

Over the past 35 years, the importance of extractive-industry income in the Rocky Mountain States has declined. Even during the current oil and gas drilling boom, this industry contributes less than 2 percent of total personal income in the region.



* In order to show the long-term trend, the figure is based on data collected through the Standard Industry Classification (SIC) system, which was used through 2000, and the North American Industry Classification System (NAICS), which has been used since 2001. (See the Appendix for a discussion of these classification systems.) The switch in classification systems is represented by the break in the graph.

Source: Regional Economic Information System, Bureau of Economic Analysis, U.S. Department of Commerce (2005 data are the most recent available).

TABLE 1.

Agricultural and Extractive-Industry Income as a Percentage of Total Personal Income in the Rocky Mountain States (2005)

The extraction of natural resources represents a relatively small proportion of total personal income in the six Rocky Mountain States. This is true despite the frenzy of oil and gas drilling that has recently been occurring in the region.

	Farming & Ranching	Mining	Oil & Gas Extraction	Timber Industry	Total Agriculture & Extractive Income
Colorado	0.6%	0.7%	1.6%	0.2%	3.2%
Idaho	4.0%	0.4%	NA	1.9%	6.3%
Montana	3.0%	1.8%	0.8%	1.2%	6.8%
New Mexico	2.2%	1.6%	1.7%	0.2%	5.7%
Utah	0.5%	0.9%	0.4%	0.4%	2.2%
Wyoming	1.5%	8.2%	4.2%	0.2%	14.1%
Rocky Mountains	1.4%	1.3%	1.3%	0.5%	4.5%
United States	1.0%	0.4%	0.5%	0.7%	2.5%

Source: Regional Economic Information System, Bureau of Economic Analysis, U.S. Department of Commerce (2005 data are the most recent available).

The Role of Protected Public Lands

The population of the rural West has been increasing since the 1970s (Bennett and McBeth 1998). The Rockies are one of the fastest growing regions in the United States (U.S. Census Bureau 2001), and, contrary to the pattern seen elsewhere, population growth has preceded employment growth in the rural West (Vias 1999). People appear to migrate to the region for its amenities (McGranahan 1999), including abundant natural and scenic resources such as varied topography, access to water bodies and a pleasant climate.

Along with population growth comes demographic change (Shumway and Otterstrom 2001). As more people move from urban areas to rural communities they bring with them expectations about how local public lands ought to be managed, and these changing community values must also be accounted for in the management of surrounding public lands.

A large and growing body of research indicates that the natural amenities provided by public lands are an important economic driver in the rural West (Rudzitis and Johansen 1989; Johnson and Rasker 1993, 1995;

What do we mean by natural amenties?

The natural amenities provided by protected public lands include quality outdoor recreation, hunting and fishing opportunities, clean air and water, scenic beauty, open spaces or natural areas, habitat for fish and wildlife, a clean environment, varied topography and access to water. The natural amenities from public land contribute to the quality of life for local residents. For example, residents of Sublette County in Wyoming cited the beautiful scenery, abundant recreation opportunities and rural lifestyle as the top three reasons they chose to live in the Rockies (McLeod et al. 1998). In addition, natural amenities attract retirees with their investment income, and an educated and talented workforce, which in turns attracts businesses to the region.

Scientists at the Economic Research Service, a branch of the U.S. Department of Agriculture, recognized the economic importance of protecting natural amenities and developed a scale that measures the level of amenities in each county. The Amenity Scale rating is based on six factors: warm winters, plentiful winter sunshine, temperate summers (not too hot), low summer humidity, variation in topography (hilliness) and water area.

The results (right) show that 91 percent of the counties in the Rocky Mountain States have amenity scores higher than the national average, and in New Mexico and Utah every county scores higher than the national average.

Counties in each state with Amenity Scale scores higher than the national average

Colorado	95%
Idaho	95%
Montana	72%
New Mexico	100%
Utah	100%
Wyoming	91%
All Rockies Counties	91%

Source: U.S. Department of Agriculture, Economic Research Service, Natural Amenities Data Base (http://www.ers.usda.gov/Data/NaturalAmenities/).

Above: Collared lizard, Mesa Verde National Park, Colorado.

Opposite Page: Backpackers hiking along the bottom of a red rock canyon.

Rasker 1994; Power 1995, 1996; Duffy-Deno 1998; Rudzitis 1999; Lorah 2000; Rudzitis and Johnson 2000; Whitelaw et al. 2003; Holmes and Hecox 2004; Rasker et al. 2004). Local communities with protected wildlands reap measurable benefits in terms of employment and personal income. Counties with high levels of natural amenities are more likely to experience both greater population and greater economic growth than counties with fewer such amenities (McGranahan 1999). Protected lands have the greatest influence on economic growth in isolated rural counties that lack easy access to larger markets. From 1970 to 2000, real per capita income in isolated rural counties with protected land grew more than 60 percent faster than in isolated counties without any protected lands (Rasker et al. 2004).

More and more workers in the West, and all over the United States, are able to choose where they live and work. Technology makes it easier for professionals to "telecommute" using electronic communications. Many businesses are able to conduct national or international commerce from any location they choose. Other entrepreneurs simply choose to live in a particular place and build a business in response to local needs. Retirees and others who collect non-labor income are not tied by a job to a specific location. Many of these people seek an attractive place to live. As development pressures increase, public lands become a backdrop or setting that contributes to or even creates the amenities that will help a community's economy thrive and grow.

Residents of counties with designated Wilderness cite the presence of that Wilderness as an important reason they moved to the county, and long-term residents cite it as a reason they stay (Rudzitis and Johansen 1989). Recent survey results also indicate that many firms decide to locate or stay in the West because of scenic amenities and wildlife-based recreation, both of which are strongly supported by Wilderness Areas (Johnson and Rasker 1995). Resource managers, economic planners and community leaders should be aware of these trends and consider the role that protected public lands play in the community's long-term economic and social health and well-being.

Many rural sociologists and economists have highlighted the role of natural resource protection in economic growth. In a study of the relationships between rural poverty and natural resource development, Freudenburg and Gramling (1994) concluded:

> …it needs to be recognized as a serious empirical possibility that the future economic hope for resource-dependent communities of...the United States could have less to do with

Protecting our Natural Treasures in Radium Springs, New Mexico

Pat Buls
Owner, Shining Heart Farms

Pat Buls' connection to New Mexico's public lands is both physical and emotional, and a daily experience. As the owner of Shining Heart Farms, a horse training and riding lesson facility in Radium Springs, Buls "rides the range" almost every day.

"America is unique in its treasure trove of wild backcountry—public land that belongs to all of us, whether we live in New Mexico, or across the country in New York City," says Buls. "I have spent my life sharing the outdoors with my students, and as a result have witnessed over and over again the healing power of wilderness."

Reflecting on a past student, Buls recalls witnessing a shy, overweight girl blossom into a self-confident, active woman due to the nourishing power of nature. Buls believes that wilderness doesn't just heal the soul, it also serves as an economic driver, especially in southern New Mexico where the area is experiencing a population surge.

"More and more people come here, drawn to this area because of its beauty and our quality of life," says Buls. "As a result, I believe it is our duty to protect our natural treasures because they serve as the backbone for our economy and our community. It is the best we can do for our children."

ABOVE: Chetro Ketl Pueblo at Chaco Culture National Historic Park, New Mexico.

OPPOSITE PAGE: For many professional and service workers, coffee and internet access are key ingredients for success in the 21st Century western economy.

> the consumption of natural resources than with their preservation.

Deller et al. (2001) echo this finding:

> Rural areas endowed with key natural resource amenities can manage those resources to capture growth more effectively. This may entail expansion beyond policies that have historically been focused on extraction of the resource base.

In addition, a letter to the president and the governors of the western states, signed by 100 economists from universities and other organizations throughout the United States, reads in part, "The West's natural environment is, arguably, its greatest long-run economic strength" (Whitelaw et al. 2003).

Key Economic Indicators for Western Communities

A number of economic indicators signal both a change in the West's economy and the health of specific communities in the West. These indicators include the rapidly expanding professional and service sector, the increasingly important role that recreation and tourism play in the region, the rise of small businesses and other entrepreneurial endeavors and the growing importance of retirees and non-labor income.

We've chosen to highlight this particular set of indicators because they have been shown to be strong drivers of rural economies (Deller 1995, Deller et al. 2001, Henderson 2004, Henderson and Abraham 2004, Low 2004, Rasker et al. 2004, Low et al. 2005). Furthermore, despite their significant role in rural economies, the indicators described here have been largely ignored in recent land management planning documents when assessing the region's relationship with its abundant public lands. We hope this information will be useful for communities where traditional extractive industries have declined, as well as for communities enduring the current oil and gas drilling boom.

The Professional and Service Sector

Over the past quarter-century, the U.S. economy as a whole has seen a shift from extractive and primary manufacturing industries to service-oriented businesses, a trend that is also evident throughout the West. A common misconception about the so-called service sector is that it includes only low-paying jobs. This is not the case; several high-paying professional occupations such as computer programmers, lawyers, financial advisors, engineers and doctors (Figure 3) are classified as part of the service sector. Many of the counties in the Rocky Mountain West with economies that are characterized by a predominance of service industries have the highest incomes (Shumway and Otterstrom 2001).

A diverse economy is important for sustainable economic development and prosperity, and given the growing importance of the professional and service sector, it is also important that this sector remain diverse, not dominated by any single segment.

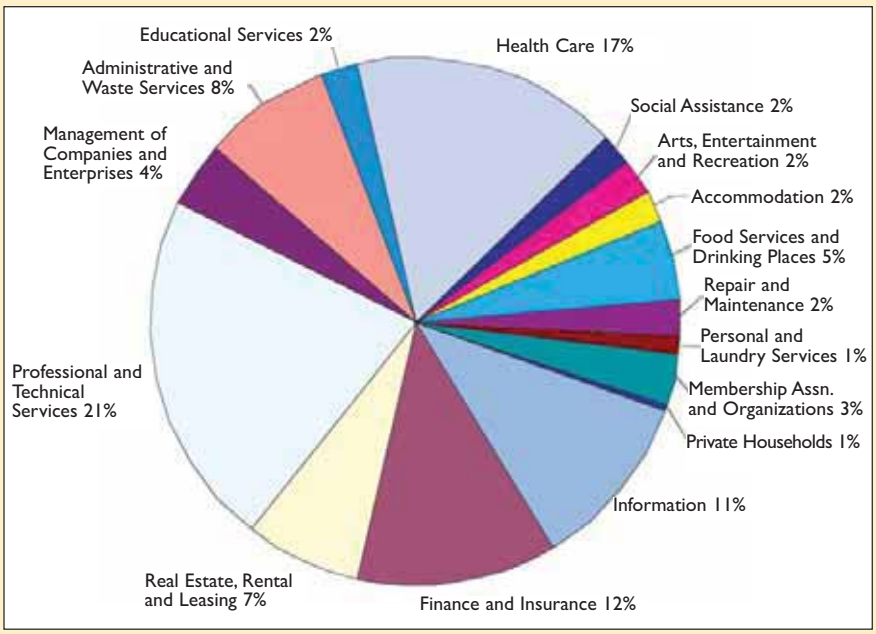
The growth in these service sector professions in the Rocky Mountain West is linked in many cases with an increase in investment and retirement income. As retirees (discussed in more detail beginning on page 17) and others migrate to rural communities, they contribute to overall income and employment (Deller 1995). Employment and income in the health-care sector may increase as the number of retirees in an area increases. As retirees move into a region, the demand for financial, insurance and real estate services may also increase. In the Rocky Mountain region, non-labor income has risen in concert with professional and service sector income in recent decades, while extractive-industry income has fallen in relative importance (Figure 4, next page).

Over the past three decades, advancing technology has played a key role in transforming the economy of the West. Improved technology results in reduced labor requirements, contributing to the downward trend in extractive-industry employment (Johnson 2001). At the same time, developments in communications and information technology have opened up new economic opportunities in the rural West, by mitigating the constraints imposed by remoteness and permitting

FIGURE 3.

Income from Professional and Service Sector Occupations in the Rocky Mountains (2005)

Contrary to common assumptions, the service sector includes a number of high-paying, knowledge-based occupations, not just entry-level jobs. In fact, in the Rocky Mountain States, some of the largest segments of the service sector, such as Information, Professional & Technical Services and Health Care, are also highly paid. Also significant is the fact that the region has a wide variety of professional and service sector occupations, since economic diversity is important for community prosperity and growth.

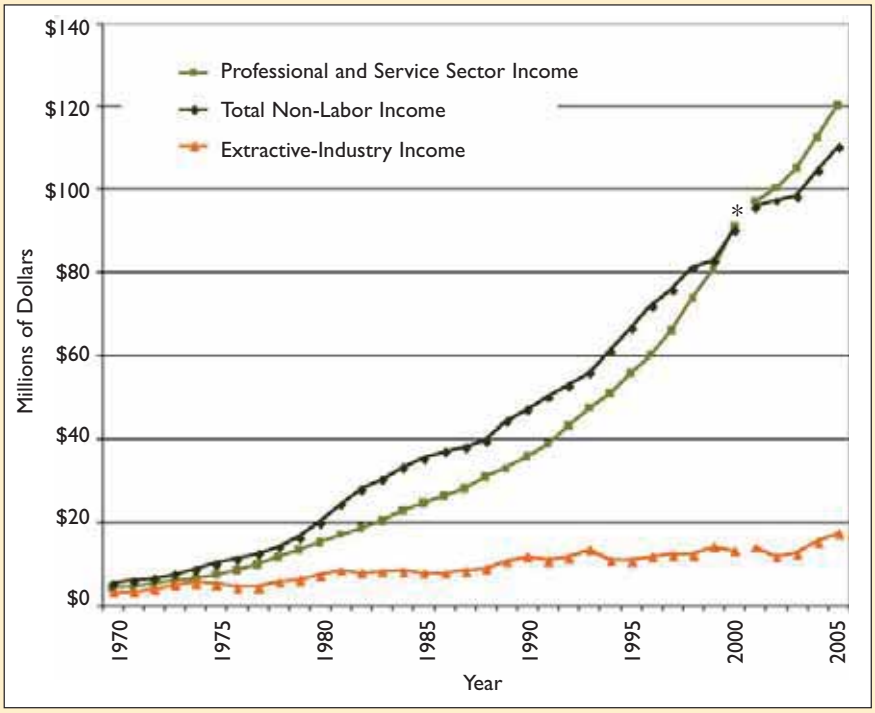


Source: Regional Economic Information System, Bureau of Economic Analysis, U.S. Department of Commerce (2005 data are the most recent available).

FIGURE 4.

Trends in Total Personal Income in the Rocky Mountains

While extractive industries have played a minor role in generating income in the Rocky Mountain States, professional and service sector income has been rising along with non-labor income. These trends highlight a shift in the region's economy as well as the need to ensure that public land management protects the natural amenities that draw high-quality workers and diverse businesses to the region.



* In order to show the long-term trends, professional and service sector income and extractive-industry income are based on SIC data for 1970-2000 and NAICS data for 2001-2005 (see Appendix). While not explicitly compatible, both classification systems show similar trends for income from the professional and service sector and extractive industries. The switch in classification systems is represented by the break in the graph.

Source: Regional Economic Information System, Bureau of Economic Analysis, U.S. Department of Commerce (2005 data are the most recent available).

employment in the professional and service sector previously unavailable for rural residents.

Many high-paying professional occupations such as those in health, educational and legal services are often referred to as "knowledge-based," defined by Henderson and Abraham (2004) as follows: "Knowledge-based activities emerge from an intangible resource that enables workers to use existing facts and understandings to generate new ideas. These ideas produce innovations that lead to increased productivity, new products and services, and economic growth."

Knowledge-based industries (such as computer programming, data processing, educational services and even museums) have grown nationwide since 1980, and

Finding a Place to Work and Play in Boise, Idaho

Bill Brudenell
Production Engineer, Hewlett Packard

Ingrid Brudenell
Professor of Nursing, Boise State University

Bill and Ingrid Brudenell moved to Boise in 1980 after a long search for a home with natural beauty, proximity to outdoor recreation and the security of protected lands. The Brudenells wanted to settle in a place where they could be sure that the natural beauty they love so much would not be destroyed.

A life-long nature lover, Bill remembers growing up near the Great Smoky Mountains in Tennessee and being awakened each morning by the singing of the birds. He was disappointed when vast tracts of the Nantahala and Cherokee National Forests were clearcut. "When there aren't any trees, well, there aren't any birds," he says.

The Brudenells lived for a time in Charlotte, North Carolina, but they found that much of the same selling off and destruction of natural lands was occurring there, making it more difficult to access natural areas with room to roam.

Realizing they needed to make a conscious effort to seek out their desired combination of easy access to outdoor recreation and exciting job opportunities, Bill and Ingrid put their heads together and found themselves headed west. They have been very happy in Boise, which has both the kind of rewarding professional work they sought and the effortless access to skiing, hiking, backpacking, mountain biking, fishing and rafting that they needed. With many of Idaho's great places enjoying protected status, the Brudenells no longer worry about losing access to many of their favorite natural areas and recreation sites.

rural areas can take advantage of this trend by enhancing the factors that contribute to the growth of these industries. Such factors include a high-quality workforce, colleges and universities, transportation and communication infrastructure and a diversified local economy. These factors are interrelated and often depend on the quality of the environment and the availability of public lands and their associated recreational opportunities. Such amenities play a strong role in attracting workers and businesses which serve to diversify economies in the rural Rocky Mountain West (Whitelaw and Niemi 1989; Johnson and Rasker 1993, 1995).

Hunting, Fishing & Recreation

According to the Outdoor Industry Foundation, 162 million Americans participate in non-motorized active outdoor recreation each year (OIF 2006a), spending $298 billion on gear and recreation services annually (OIF 2006b). This spending spurs other spending in local economies as well as generating local tax revenues—making the total national

TABLE 2.

Hunting, Fishing and Wildlife Watching in the Rocky Mountains (2006)

Wildlife recreation is an important part of the cultural heritage of the Rocky Mountain States and an important source of economic activity in rural communities. Over 4 million people participated in hunting, fishing and wildlife watching in the region, spending over $7 billion.

	Participation	Expenditures
Colorado	1,593,000	$2,424,196,000
Idaho	564,000	$840,267,000
Montana	511,000	$910,049,000
New Mexico	581,000	$807,618,000
Utah	794,000	$1,193,655,000
Wyoming	230,000	$904,780,000
Rocky Mountain States Total	4,273,000	$7,080,565,000

Source: U.S. Department of the Interior, U.S. Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau, 2007.

Top: Canoeing in the Upper Missouri River Breaks National Monument, Montana.

Above: Rainbow trout are prized by anglers throughout the Rockies, where fishing generated over $2 billon in spending in 2006.

Below: A fisherman on Snowmass Creek in the Maroon Bells-Snowmass Wilderness Area, Colorado.

ABOVE: A local outfitter leads a pack trip into the spectacular ranges of the Absaroka-Beartooth Wilderness Area of south-central Montana.

AT RIGHT: A young camper seizes the day in the San Rafael Swell, Utah.

OPPOSITE PAGE: Bull elk. Hunting and wildlife watching bring over $4 billion to the Rocky Mountain States' economies.

economic contribution of outdoor recreation over $730 billion (OIF 2006b). The total economic contribution of non-motorized recreation in just the six-state Rocky Mountain region was over $22 billion in 2006 (OIF 2007).

Outdoor recreation by residents and tourists alike is an important component of western economies. Many rural communities in the Rocky Mountain region have been revitalized as they have been "discovered" by recreationists. Moab, Utah, for example, was once a dying mining center and is now a top destination for recreation seekers of all sorts. Tourism also leads to migration by new residents who may bring new businesses; one study found that a quarter of the business owners in the Yellowstone National Park region first came to the area as tourists (Snepenger et al. 1995).

An April 2004 report from the Federal Reserve Bank of Kansas City's Center for the Study of Rural America calls wildlife recreation "rural America's newest billion-dollar industry" (Henderson 2004). Nationwide, wildlife recreation—hunting, fishing and wildlife watching—generated $120 billion in spending for local economies, boosting tourism, spurring business growth and contributing to increased property values. Hunters, anglers and wildlife watchers spent over $7 billion in the six-state Rocky Mountain region alone in 2006 (U.S. Fish and Wildlife Service and U.S. Census Bureau 2007) (Table 2).

As the nation's population grows, public lands become more and more necessary for providing the open space

and healthy wildlife habitat required for quality hunting, fishing and other outdoor recreation opportunities. The Forest Service has estimated that its recreation and protection programs account for much greater economic benefits than do its resource-extraction programs (Alward et al. 2003). Maintaining habitat for the fish and wildlife sought by anglers and hunters is a wise investment for western communities.

Entrepreneurs

While the previous sections discussed wage earners, this section focuses on the self-employed entrepreneurs in the Rocky Mountains, many of whom work in the professional and service sector and/or recreation-oriented businesses. The Center for the Study of Rural America includes the level of entrepreneurship as a regional asset that indicates economic viability, and notes that entrepreneurs can increase the health of the overall

Profiting from the Beauty of Wilderness in Nampa, Idaho

Tyler Welshimer (right), owner of bicycle repair business Welshimer Wheels, LLC, works on a racer's mountain bike just prior to the annual White Knob Challenge mountain bike race in the Lost River Mountains of eastern Idaho. The race, which starts on Main Street in Mackay, Idaho, attracts about 130 racers and their families from across the West.

Races such as the White Knob Challenge are an important source of income for Welshimer Wheels and other businesses in Idaho. For several days before and after a bicycle race, hotels, eateries, gas stations and campsites enjoy increased business. "When I officiate at races the motel parking lots are usually flooded with bike-laden cars and there are many 'no-vacancy' signs out—I guess I'm not the only one to profit from the beauty of wilderness," observes Welshimer.

He continues, "Mountain bike races are often held just outside of wilderness areas and in places of spectacular natural beauty. Without protected lands, cyclists would not be drawn to the area, and without cyclists I don't have bikes to fix."

Tyler Welshimer
Welshimer Wheels, LLC

TABLE 3.

Non-Labor Income as a Percentage of Total Personal Income (2005)

Non-labor income in the Rocky Mountain region and the United States as a whole consists mainly of retirement and investment income. Income support is a small portion of total non-labor income and an even smaller portion of total personal income, and for most states in the region income support is lower than in the United States overall.

	Investment Income [a]	Retirement Income [b]	Income Support [c]	Other Transfer Payments [d]	Total Non-Labor Income
Colorado	16%	7%	2.8%	0.7%	26%
Idaho	18%	10%	4.2%	1%	33%
Montana	19%	11%	4.4%	1%	36%
New Mexico	15%	10%	6.8%	11%	33%
Utah	14%	7%	3.3%	1.07%	26%
Wyoming	23%	9%	3.3%	0.8%	36%
Rocky Mountains	16%	8%	3.7%	0.9%	29%
United States	16%	9%	4.9%	1%	31%

[a] Dividends, interest and rent
[b] Includes veterans' benefits, military benefits and Medicare
[c] Income maintenance benefits (Supplemental security income, Family assistance, Food stamps, Other income maintenance benefits), Public assistance medical benefits and Unemployment insurance compensation
[d] Includes federal education and training assistance, settlements between individuals and businesses and transfer payments from non-profit institutions

Source: Regional Economic Information System, Bureau of Economic Analysis, U.S. Department of Commerce (2005 data are the most recent available).

economy: "Entrepreneurs create local jobs, wealth, and growth—and are themselves innovative users of other regional assets and resources.…Entrepreneurs bolster a region's quality of life while promoting economic prosperity. Research has found a strong correlation between entrepreneurship and long-term regional employment growth" (Low 2004).

Entrepreneurs in many fields—especially high-technology and knowledge-based fields—are often free to choose their location, and gravitate towards high-amenity areas (Rasker and Glick 1994, Johnson and Rasker 1995, Snepenger et al. 1995, Beyers and Lindahl 1996, Rasker and Hansen 2000, Henderson and Abraham 2004, Low 2004, Low et al. 2005). Recreation- and tourism-oriented businesses are often founded by footloose entrepreneurs seeking to live and work in areas rich in natural amenities and recreation opportunities. Retirees and investors migrating to an area bring with them entrepreneurial opportunities for those who can provide the goods and services they seek.

Entrepreneurs who provide producer services (services sold primarily to other businesses and government) are also expanding in rural areas, and most of these conduct much of their business interregionally or even internationally, bringing outside income into the rural regions where they are located. Producer services are often high-paying occupations such as computer programming and data processing; engineering and architectural services; management consulting; and insurance, legal, financial and accounting services. Most of these businesses are not location dependent and entrepreneurs in these fields can often choose their location based on the amenities available in many rural areas (Beyers and Lindahl 1996).

Although wage and salary income is still the largest portion of total personal income in the Rocky Mountain States, entrepreneurs' income has grown slowly but steadily from less than 10 percent of total personal income in 1970 to nearly 12 percent in 2005. Decisions to locate new businesses in rural areas are often made for quality-of-life reasons, providing further evidence of the importance of natural amenities to local economies (Rasker and Glick 1994, Beyers and Lindahl 1996).

Retirees and Non-Labor Income

In the Rocky Mountain States, investment and retirement income makes up nearly one-quarter of total personal income, making it one of the top "industries" in the region and an important contributor

to the economy that must be included in economic impact analyses. Investment and retirement income is by far the largest portion of non-labor income in each of the Rocky Mountain States (Table 3).

Areas with high levels of natural amenities—such as the scenic beauty and abundant recreation opportunities of nearby intact landscapes and Wilderness Areas—attract residents, and many of these residents rely on non-traditional sources of income (Duffy-Deno 1998, McGranahan 1999, Nelson 1999, Rudzitis 1999, Shumway and Otterstrom 2001, Lorah and Southwick 2003). Not bound by their job to any particular location, retirees can choose a place to live based on the amenities it offers. People who rely on retirement and investment income are concentrated in the coastal and mountain regions of the West, precisely because of the natural amenities these areas possess (Nelson 1999). An influx of retirees to rural communities has been shown to have positive effects on both income and employment (Deller 1995). When a person receives dividends on his or her investments or a retiree receives a pension check, the money represents an influx of income for the entire local economy, and in turn fuels increases in employment and income for many of the other sectors discussed in this report.

Discovering New Economic Springs in Kanab, Utah

Willow Canyon Outdoor

"We describe our arrival in southwest Utah 13 years ago as serendipitous. Although we were always drawn to the intimate canyons and vast landscapes, we were somehow surprised to find ourselves living among them. In a sense, the rural West is full of those kinds of unexpected blessings, like when a sudden cloudburst ends a long dry spell.

"Many of our neighbors are struggling through a sort of economic drought—the bust that seems always to be on the heels of the latest boom in extractive industry. Our first year in Kanab, the lumber mill was shut down. It had never been retrofitted to cut the smaller logs of secondary forests, and old growth was getting scarce. You can count the lost jobs and measure the economic impact, but it's harder to reckon with the family and friends that had to leave the community to make a living elsewhere.

"Meanwhile, our local economy has quietly shifted. Our little shop is a reflection of that—'We provide unique goods and services to help people discover, experience, understand, and appreciate the natural and cultural wonders of the Colorado Plateau,' reads our mission statement. We sell outdoor gear, books, and gourmet espresso. Still, it's a bumpy road for entrepreneurs, and ideas that didn't work out roll around like tumbleweeds.

"It doesn't surprise us that so many people are skeptical as they watch the New West evolve. Its development is punctuated with loss and resentment almost as much as with hope and renewal. A flood of change can seem very threatening, even while awash with opportunity.

"Within our community, we're all searching for common ground, for an identity, for a vision of what our town should be. This is the high desert, and you never really know when it's going to rain again."

— Susan Hand and Charlie Neumann, owners

Recommendations and Discussion

The preceding sections of this report have presented some key indicators for the western economy in the 21st Century. These indicators should also be included in the socioeconomic impact analysis for land management planning in order to ensure that the decisions affecting our public lands are based on an analysis that accurately reflects the West's economy. This section makes some specific recommendations that citizens in western communities and public land managers can use to improve the land management planning process. An Appendix (pages 26-28) provides further information about some of the sources of the types of data called for here.

Improve the Socioeconomic Impact Analysis in Public Land Management Plans

The National Environmental Policy Act (NEPA) requires federal agencies to take a "hard look" at the impacts of a proposed action such as oil and gas development. These impacts include ecological, aesthetic, historic, cultural, economic and social impacts. Such impact analysis requires high-quality data on both the current conditions and the potential outcomes of land management actions. Federal agencies cannot evaluate the consequences of proposed decisions or determine how best to avoid or mitigate negative impacts without adequate data and analysis.

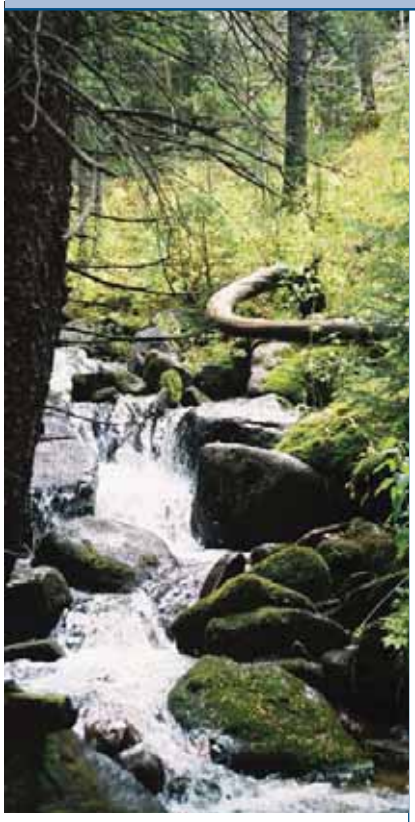
By using high-quality data, applying sound scientific methods and examining the key indicators described in this report, we believe that public land management agencies can better fulfill their obligations to evaluate the direct, indirect and cumulative socioeconomic impacts of various alternative decisions. In this section, we provide both general recommendations on the scope of the socioeconomic impact analysis and specific inquiries to be made in this analysis.

Above: Spring skiing in Mt. Naomi Wilderness Area, Utah.

Recommendation 1. The socioeconomic impact analysis for public land management planning should include an analysis and discussion of both the current status of and historic trends in jobs and in personal income—including trends in retirement and investment income, the professional and service sector, jobs and income from hunting, fishing, recreation and tourism and entrepreneurial income.

In general, it is inappropriate to examine a region's economy solely at a single point in time because economies are dynamic. Trend analysis will show long-term patterns in income and employment that may be masked when looking at only one point in time. Trend analysis can help guide resource management by showing the likely future situation in an area and pointing out historic periods of economic downturn. It may be instructive to look at other variables during these downturns to see if there are correlations between land management activities and economic activity. Looking at trends in employment and income is important to understanding the overall direction in which an area's economy is moving.

The analysis of regional economic impacts must include an analysis of all sources of income, including entrepreneurial and non-labor income. The analysis should also examine the role that amenities, including recreation opportunities and environmental quality, currently play in attracting and retaining entrepreneurs and non-labor income to the area. Finally, the analysis should examine the potential impacts that public land management alternatives will have on the level and trend of entrepreneurial endeavors and investment and



ABOVE: Protected public lands like the Pike-San Isabel National Forest in Colorado help ensure that streams like this one retain their high water quality.

OPPOSITE PAGE, TOP: Serrate Ridge and Scree Lake, Boulder White Clouds Wilderness Area, Idaho.

OPPOSITE PAGE, BOTTOM: Agave flower, New Mexico.

retirement income in the area.
A full accounting of all sources of income is necessary to understand the important role that entrepreneurs and retirement and investment income play in the regional economy. An economic impact analysis that excludes these sources of income is inadequate and misleading.

RECOMMENDATION 2. The economic impact analysis for public land management plans should include an analysis and discussion of the indirect role protected public lands play in the regional economy in attracting retirees and entrepreneurs, including those in knowledge-based businesses, service sector businesses, recreation and tourism businesses and other sectors.

Public wildlands often define the character of an area and represent an important component of the quality of life for local residents and future generations. Their protection enables the lifestyles of western communities to continue. The socioeconomic analysis also must account for these economic benefits.

As discussed above, a growing number of economists are recognizing that protecting amenities and the natural environment are key in attracting new residents and businesses to western communities, and that therefore the environment is the engine propelling the regional economy. Researchers have long known that a community's ability to attract and retain a high-quality workforce is key to its prosperity. The natural environment, including the amenities found on or near protected public lands, has been found to be important in attracting such workers and firms. Given these findings, the economic impact analysis of management alternatives for public lands should fully consider the indirect role of these lands in attracting and retaining recreational and non-recreational businesses and retirees, as well as their role in encouraging entrepreneurial efforts.

The potential impacts that public land management alternatives will have on non-extractive industries and on the ability of proprietors to start and grow businesses (especially if extractive activities are accelerated on public lands in the area) should be assessed, including the potential impacts of public land management alternatives on the overall makeup of the economy of the area, as well as the factors that have attracted new businesses to the area.

Brewing Success in Fort Collins, Colorado

New Belgium Brewing has been committed to sustainable business practices since its inception in 1991. Water is a key ingredient of beer, and water conservation is also an important environmental concern in the western United States. As brewers, New Belgium takes that seriously. New Belgium relies on clean water for its great-tasting beers. That is part of the reason they take it upon themselves to ensure that the watershed in which they reside remains healthy and clear.

Jeff Lebesch and Kim Jordan
Founders, New Belgium Brewing

New Belgium practices the three "R's" of environmental stewardship—reduce, reuse, recycle. Motion sensors on the lights throughout the building and low-water landscaping reduce energy and water use. New Belgium reuses heat for the brewing process, cleaning chemicals, water and much more. Recycling at New Belgium takes on many forms, from turning "waste" products into something new and useful (like spent grain to cattle feed), to supporting the recycling market in creative ways (like turning keg caps into table surfaces). New Belgium also buys recycled whenever possible.

New Belgium's founders chose the location for their business based on its access and proximity to Colorado's natural beauty. As a business based on ecological responsibility, made up of people concerned about conservation and sustainability, New Belgium recognizes that they rely on a healthy environment to make their delicious brews, and that without protected lands and waters, it may be much more difficult to produce the quality product they now make.

Recommendation 3. The socioeconomic analysis must account for the economic importance of the recreation, hunting and fishing that occurs on public land. The recreation opportunities provided by Wilderness-quality public lands yield direct economic benefits to local communities. The socioeconomic analysis must include an analysis of the income and jobs associated with recreation, hunting and fishing under each alternative.

The impact analysis should utilize data on participation in all recreation activities (hunting, fishing, hiking, camping, backpacking, biking, skiing, wildlife watching, boating, ORV use, etc.), as well as data on expenditures by recreation visitors in the region. If these are not readily available they should be collected. These data should be used to analyze the economic impact of expenditures by recreationists, hunters and anglers on area businesses and local economies. Also, the analysis should examine the role of lodging taxes, sales taxes and property taxes in the local economy. Finally, the potential impact of public land management alternatives on recreation, hunting and fishing businesses should be examined.

Recommendation 4. The socioeconomic analysis of oil and gas drilling proposals must be based on the oil and gas resources that are economically recoverable, not the resources that are only technically recoverable. The economic analysis of recoverable resources should fully account for the hidden costs to communities and the environment associated with drilling (Morton et al. 2004).

Recent energy-driven land management plans have consistently exaggerated the energy potential of public lands by ignoring the observable economic costs of drilling and production. Such oversight

will also exaggerate the importance of the oil and gas industry in the regional economy. In addition, oil and gas drilling is associated with hidden costs—increased road maintenance and law enforcement costs, increased air and water pollution, declining property values, etc.—that must be internalized in the socioeconomic analysis completed in support of decisions affecting public land. For more details on these recommendations see Morton et al. (2004).

Plan for Amenity Development

Protecting public lands can also lead to development, and managing this development is important to ensure the protection of natural amenities. While amenity development may be a desirable alternative to the boom and bust of an extractive industry-based economy, it does—like any development—have economic and ecological costs (Hansen et al. 2002, Rasker et al. 2004). Ironically, some of these costs are similar to the hidden costs associated with oil and gas drilling. For example, negative ecological effects of amenity development can include loss of native species, changes in natural disturbance regimes (such as wildfires) and the spread of invasive species (Hansen et al. 2002). In addition, areas that grow too quickly, regardless of the drivers of this growth, can experience rising housing costs (Morton 2000, Rasker et al. 2004). This can sometimes squeeze long-time residents out of the area, diminishing the social amenities that drew new residents to the area in the first place. Community planners must prepare for these possibilities and develop strategies to ensure that an "amenity boom" doesn't have the same negative impacts as an oil and gas boom.

The Sonoran Institute (2007) succinctly states the challenges faced by growing communities in the Rockies:

> Ranches and open space are giving way to subdivisions. Homes and jobs are often far apart, and streets are gridlocked. Many rural communities outgrow their small town character. Retirees also look south of the border for affordable, resort-style living. Sources of energy and water are strained.

Communities that take an active role in planning for amenity-driven growth are better able to face these challenges and find a balance between growth and maintaining their quality of life (Howe et al. 1997). It is also important for communities to make sure that the broadest spectrum of residents participate in the

Building a Wilderness Business in Choteau, Montana

Gene Sentz
Wilderness Guide

Gene Sentz first hiked into Montana's Rocky Mountain Front more than 40 years ago. A retired teacher who still works as a mountain guide and mule packer out of Choteau, Montana, Sentz has long known that protected, pristine places provide both a high quality of life and solid economic opportunities.

Reflecting on the Front, Sentz says: "I knew I'd found heaven. The discovery was confirmed when I landed a seasonal job in the mountains and rode horseback into the Bob Marshall Wilderness. The 'Front' has been my home ever since.

"Today more and more Americans are attracted by, and have come to treasure, our national wildlands in the West," continues Sentz. "The intrinsic values of these precious public lands naturally cause citizens to want to live and work near them."

Sentz feels extremely fortunate that the niche he's carved out for his business, guiding hunters and summer guests along the peaks and prairies that make up the Front, enables him to experience some of his favorite wild places daily: "The splendid alpine scenery, unbeatable wildlife resource and unbroken habitat of this special place are the qualities that drew me here to begin with."

He adds, "The more we experience our public lands, the more we want to keep them free from misuse. We learn to love them like part of ourselves."

planning process, and that the process is based on a sound understanding of local resources and utilizes the assets and human capital already existing in the community. Successful communities also take an active role in protecting local amenities by purchasing open space and implementing other strategies, such as conservation easements, which complement the existing management of local public lands. Another land management planning strategy that can help to ensure that the ecological values and amenities of open space and wildlands are protected include integrating private and public land management (Hansen et al. 2002). By employing such strategies, communities can slow down the pace and scale of amenity-based development, ensuring that scenic beauty, small-town character and a sense of community are not sacrificed in the name of growth.

The Rocky Mountain region can capitalize on its wealth of natural amenities and still retain the high quality of life that residents treasure by maintaining a diverse economy (including a diverse service sector), maintaining affordable housing, developing carefully planned growth guided by zoning and protecting open space (including agricultural lands and ranches).

Slow the Pace of Oil and Gas Drilling

Much of our discussion of the threats to economically important natural amenities has centered on oil and gas drilling. Economic diversity is the key to sustaining healthy communities over the long term, and the oil and gas industry can be a part of a diverse mix of industries in the Rockies. However, when drilling takes place at the rapid pace and over the large expanses of land as seen in recent years, our natural amenities suffer, leaving western communities more vulnerable to the inevitable downturns in the oil and gas industry.

By slowing the pace of oil and gas development, the upheaval and loss of economic diversity can be minimized (Haefele and Morton 2007). While some places are simply too wild to drill and should be protected, in areas where drilling is appropriate we recommend phased development of oil and gas resources. Phased development involves incrementally opening an area for development, limiting the total area developed and/or limiting the percent of the area disturbed at any one time. Phased development

BELOW: Air pollution from oil and gas operations (such as this compressor station) near Pinedale, Wyoming, has resulted in declining visibility in the nearby Bridger Wilderness Area and Yellowstone National Park.

can also involve: 1) limiting the number of drilling permits that will be granted; 2) limiting the number of rigs permitted to operate in an area at one time; and 3) developing one area at a time, only moving to a new area once the first area is fully restored to baseline conditions.

Collecting baseline data and monitoring socioeconomic and environmental impacts are essential components of phased development. Oil and gas drilling would be initiated at a small scale and expanded only if the monitoring data show no significant environmental or socioeconomic impacts, and show that disturbed areas have been successfully restored to prior conditions. Implementing phased development can help moderate the boom and bust impacts of oil and gas drilling on communities, protect the other values associated with public lands and protect the natural amenities that are the backbone of the western economy.

Extending the period over which the development takes place will allow communities to better absorb the social and economic impacts of oil and gas development. The potential influx of new residents will be dampened. At the same time it may be more likely that local residents will have time to acquire the skills necessary to take advantage of the employment that drilling and production may bring. This may reduce many of the negative social impacts of rapid oil and gas drilling and reduce the added costs to communities. Revenue to the local government will be spread out over a longer time, allowing for a longer, more predictable and stable revenue stream (Haefele and Morton 2007).

Conclusion

The Rocky Mountain region is one of the fastest growing in the country. This growth is fueled in part by an abundance of protected public lands and the natural amenities they provide. These trends are likely to continue and even intensify in the future. The current boom in oil and gas drilling, however, is threatening the long-term health of the West's regional and local economies. We hope that this report and the recommendations contained within will provide citizens, communities and decision makers with better information for balancing the extraction, recreation and amenity values of our public lands in the Rocky Mountains.

Getting Inspired to Make a Difference in Paonia, Colorado

Chaco was founded in 1989 in the small western-Colorado town of Paonia. After rafting the Gunnison River, which flows through town, river guide and custom footwear maker Mark Paigen realized that Paonia's mild climate and slow pace of life made it a great place to live and build a business. He set up shop near the banks of the Gunnison and set out to create a great-fitting river sandal that would outlast the competition—one that could be repaired rather than thrown into a landfill.

Chaco
Casual Footwear Manufacturer

Now, Chaco employs 143 people, distributes its products in 21 countries, and continues to cultivate a business model and corporate culture inspired by its beautiful natural setting. Chaco donates 10 percent of its profits to organizations dedicated to caring for people and the planet, for example, and pays its employees to bike to work, volunteer their time and advance their education. In a town like Paonia, where bike paths glide past pleasant scenery and opportunities to get involved in the community abound, it's easy for employees to make a difference in these ways.

With a keen understanding of what's at stake, Chaco has watched with concern as the Rocky Mountain region has become ground zero for rapid oil and gas development. In response, the company has become involved in efforts to find a path away from fossil fuels. This year, Chaco purchased 500 megawatt-hours of wind-powered Green Certificates to match 100 percent of the company's electrical usage and reduce its carbon dioxide emissions by nearly 700,000 pounds.

End Notes & Photo Credits

End Notes

1 Wildlands on federal public lands include National Parks, designated Wilderness Areas, Wilderness Study Areas, Citizen-Proposed Wilderness Areas, Roadless Areas, National Monuments, National Wildlife Refuges and public land in the Bureau of Land Management's National Landscape Conservation System.

2 See for example: "Silt couple selling 110-acre ranch," *Grand Junction Daily Sentinel*, 26 February 2007; "Boom hits county roads," *Casper Star-Tribune*, 13 December 2006; "Poachers making a killing in West's oil, gas fields," *USA Today*, 15 February 2007; and "Boomtown Blues," *The New Yorker*, 5 February 2007.

3 It should be noted that while many communities in the Rockies do receive a great deal of income from oil and gas royalties and other taxes, these revenues should be considered in their proper context—compared with the many costs that oil and gas drilling imposes on communities. When these costs are considered, revenue from oil and gas drilling will be less important to the overall economy even in these communities.

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Appendix

Sources of Data

High-quality data are important for thorough and accurate assessments of a community's economy and the potential impacts of public land management alternatives. This section presents several sources of data at both the state and national levels that are available for both land managers and community residents.

Economic and Demographic Data

Data are available for several economic indicators by county from the U.S. Department of Commerce, Bureau of Economic Analysis, and the U.S. Department of Labor, Bureau of Labor Statistics. The U.S. Census Bureau also tracks economic trends along with demographic trends, most by county as well. Economic profiles showing these and other trends for selected states and counties are available at The Wilderness Society's website, www.wilderness.org.

Selected National Level Economic and Demographic Data Sources:

Bureau of Economic Analysis (U.S. Department of Commerce): *http://www.bea.doc.gov*

Data on income, farm income, transfer payments and employment for states, counties and regions. Annual data, 1969-2000 (Standard Industry Classification) and 2001-forward (North American Industry Classification System).

Bureau of Labor Statistics (U.S. Department of Labor): *http://www.bls.gov*

Data on income, wages and salaries, employment and unemployment rates by industry, for counties, states and regions. Monthly data, 1990-2005.

Census Bureau (U.S. Department of Commerce): *http://www.census.gov*

Data on population, demographics and businesses for states and counties.

Regional Asset Indicators, Federal Reserve Bank of Kansas City: *http://www.kc.frb.org/RuralCenter/Indicators/Indicators_main.htm*

Indicators for every county in the United States covering entrepreneurship, wealth, creative workers, amenities and other attributes.

U.S. Department of Agriculture, Economic Research Service: *http://www.ers.usda.gov/Data/*

Data on natural amenities, the creative workforce, the level of urbanization and other attributes for every county in the United States.

The Sonoran Institute Economic Profile System: *http://www.sonoran.org*

Generates detailed economic profiles, including trends in employment and income, farm income, economic resilience and demographics for states, counties or groups of counties. The companion, Economic Profile System—Community (EPSC), will generate profiles to reflect just the rural or urban areas of a county.

Rasker et al. (2003) show trends in income and employment for the entire western United States, using output from the Economic Profile System.

See the EPS users manual for more information: Sonoran Institute. 2004. *Economic Profile System Users Manual*. Sonoran Institute, Tucson, AZ. Available from *http://www.sonoran.org/programs/socioeconomics/si_se_manual.html*.

Selected State Economic and Demographic Data Sources:

Colorado Economic and Demographic Information System: *http://www.dola.state.co.us/is/cedishom.htm*

State of Idaho, Division of Financial Management: *http://dfm.idaho.gov/*

Montana Census and Economic Information Center (CEIC): *http://ceic.commerce.state.mt.us/*

New Mexico Labor Market Information: *http://www.dol.state.nm.us/dol_lmif.html*

New Mexico Economic Development Data Center: *http://ww1.edd.state.nm.us/index.php?/data/C31/*

Utah Governor's Office of Planning and Development, Demographic and Economic Analysis: *http://www.governor.utah.gov/dea/*

Wyoming Department of Administration and Information, Economic Analysis Division: *http://eadiv.state.wy.us/*

Recreation Data

Data on recreation use in the area where a land management plan is being developed are critical to making an informed decision. Surveys of users at recreation areas can be utilized to obtain information on the levels and types of recreation use. Information on users' expenditures in the area is also important to learn the overall economic impact of public lands recreation. Federal land management agencies collect some data on recreation use of public lands. The Bureau of Land Management's Recreation Information Management System (RIMS) and the USDA Forests Service's National Visitor Use Monitoring System (NVUMS) are two examples.

The Outdoor Industry Foundation has also done research on active recreation participation (OIF 2006a) and on the economic impacts of this participation (OIF 2006b). These and other reports are available from *http://www.outdoorindustryfoundation.org/resources.research.html*.

Other information may be obtained through surveys of local residents and recreation visitors, and by using existing data on the recreation and tourism revenues to local businesses and the value of these activities to participants. The lack of complete visitation data does not justify ignoring the jobs and income from recreation. Furthermore, the Data Quality Act requires use of the best available, reliable data on all impacts and affected sectors of the economy.

Several examples of research on recreation use, values to participants and expenditures are available (a very limited sample includes: Fix and Loomis 1997, Chakraborty and Keith 2000, Loomis 2000, Cordell and Tarrant 2002, Kaval and Loomis 2003). Rosenberger and Loomis (2001) present a detailed bibliography of recreation valuation studies and present methods by which analysts can transfer estimates of the value of recreation in one area to other similar areas.

Data on Hunting, Fishing and Wildlife Watching:

The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: *http://www.census.gov/prod/www/abs/fishing.html*

Data at the state level on participation in and expenditures for wildlife-associated recreation from the U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, Census Bureau.

The link above contains detailed reports for each state from the 2001 report. A more recent (2007) preliminary national summary is available from *http://library.fws.gov/nat_survey2006.pdf*.

Colorado Division of Wildlife: *http://wildlife.state.co.us/index.asp*

Idaho Fish and Game: *http://fishandgame.idaho.gov/*

Montana Fish, Wildlife, and Parks: *http://fwp.state.mt.us/default.html*

New Mexico Game and Fish: *http://www.wildlife.state.nm.us/index.htm*

Utah Division of Wildlife Resources: *http://wildlife.utah.gov/index.php*

Wyoming Game and Fish: *http://gf.state.wy.us/*

Industry Classification Using SIC and NAICS

Over the years there have been changes in the way that government agencies classify various industries. Income and employment data from the Bureau of Economic Analysis and the Bureau of Labor Statistics for 1969-2000 are classified according to the Standard Industry Classification system (SIC), while the most recent data (2001 and forward) are classified by the North American Industry Classification System (NAICS). NAICS was developed jointly by the United States, Canada and Mexico in order to make statistics comparable across all three countries.

NAICS provides greater detail for the service and professional sectors, which are of growing importance in the rural West and indeed all over the country. This classification scheme also includes some emerging industries such as "information," which includes the growing Internet and information phenomenon. The Bureau of Economic Analysis's Regional Economic Information System (REIS) uses SIC to classify industries and the Sonoran Institute's Economic Profile System uses SIC data from the REIS in order to show trend analyses, along with NAICS data.

We have used both SIC and NAICS data to show long-term trends in this report. In Figure 2, Farming and Ranching includes the following SIC categories for 1970-2000:

- Farm proprietors' income
- Farm earnings
- Agricultural services
- Fishing

The NAICS categories included for 2001-2005 are:

- Farm proprietors' income
- Farm earnings
- Fishing, hunting and trapping
- Agricultural and forestry support activities

Also in Figure 2, the Timber Industry includes the following SIC categories (1970-2000):

- Forestry
- Lumber and wood product manufacturing
- Paper and allied products manufacturing

The NAICS categories included for 2001-2005 are:

- Forestry and logging
- Wood product manufacturing
- Paper manufacturing

In Figure 4, Professional & Service Sector Income includes the following SIC categories (1970-2000):

- Eating and drinking places
- Finance, insurance and real estate
- Services

The NAICS categories included for 2001-2005 are:

- Finance and insurance
- Real estate and rental and leasing
- Professional and technical services
- Management of companies and enterprises
- Administrative and waste services
- Educational services
- Health care and social assistance
- Arts, entertainment and recreation
- Accommodation
- Food services and drinking places
- Other services, except public administration

Also in Figure 4, Extractive-Industry Income includes the following SIC categories (1970-2000):

- Farm proprietors' income
- Farm earnings
- Agricultural services, forestry, fishing
- Mining
- Lumber and wood products manufacturing
- Paper and allied products manufacturing

The NAICS categories included for 2001-2005 are:

- Farm proprietors' income
- Farm earnings
- Forestry, fishing, related activities
- Mining
- Wood product manufacturing
- Paper manufacturing

Total Non-Labor Income consists of transfer payments plus dividends, interest and rent. (There is no difference in non-labor income between the two classification systems; a break was included in this line in order to avoid obscuring the break in the Professional and Service Sector Income line.)

Despite incompatibilities between these classification systems, one can certainly look at a general picture of the economy over time by using both sets of data. This analysis should be applied to all the segments of the economy to see the long-term trends in both extractive and other industries along with non-labor income.

Protected Public Lands

In 1964 Congress passed the Wilderness Act which allowed for certain areas of public lands to be protected from development as part of a National Wilderness Preservation System. Described by Aldo Leopold (1949) as "…a resource which can shrink but not grow," designated Wilderness comprises 107 million acres nationwide.

Wilderness Areas are designated by Congress, and defined by the Wilderness Act as places "where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Designation is aimed at ensuring that these lands are preserved in their natural condition. Wilderness Areas offer outstanding opportunities for solitude or a primitive and unconfined type of recreation; such areas may also contain ecological, geological or other features that have scientific, scenic or historical value.

Other types of protected public wildlands include National Parks, National Monuments, National Conservation Areas, Wilderness Study Areas, Citizen-Proposed Wilderness Areas, Forest Service Roadless Areas, National Wild and Scenic Rivers, National Scenic Trails and National Historic Trails. While many of us are familiar with National Parks, some of the other designations are less well known. These are defined below.

National Monuments are established by the president (under the authority of the Antiquities Act of 1906) or Congress to protect objects of scientific and historical interest that are located on federal land.

National Conservation Areas are designated by Congress to provide for the conservation, use, enjoyment and enhancement of certain natural, recreational, paleontological and other resources, including fish and wildlife habitat.

Wilderness Study Areas are designated by the managing agency (for example, the Bureau of Land Management or the Forest Service) as having potential wilderness characteristics, thus making it worthy of consideration by Congress for Wilderness designation.

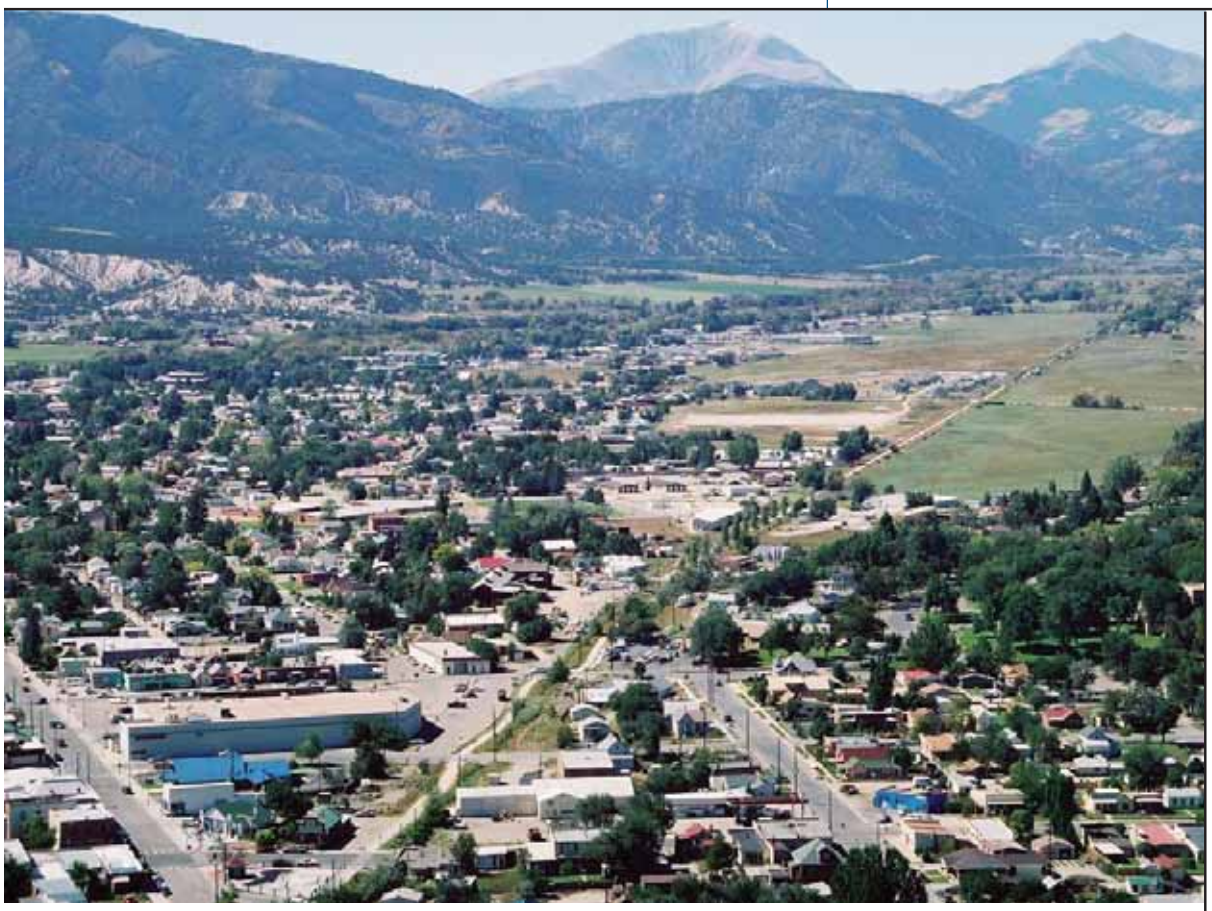
Continued on next page

Citizen-Proposed Wilderness Areas also have wilderness characteristics that have been identified through on-the-ground inventories conducted by citizens, who consider the areas to be worthy of Congressional designation as Wilderness and have brought them to the attention of the federal land management agency.

Forest Service Roadless Areas represent additional wild lands in the National Forests which have wilderness characteristics and are also expected to merit Congressional designation as Wilderness.

National Wild and Scenic Rivers are designated by Congress, under the authority of the Wild and Scenic Rivers Act, to protect remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values and to preserve the river or river section in its free-flowing condition.

National Scenic Trails and National Historic Trails are designated by Congress under the National Trails System Act, and offer exceptional outdoor recreation along trails that have scenic, historical, natural or cultural values. Designation protects the routes and their artifacts for public use and enjoyment.



ABOVE: Salida, Colorado was named one of America's best towns by Outside *(August, 2004), in part because of the access to abundant outdoor recreation on nearby public lands.*

THIS PAGE: Wildlife — like these pronghorn in Wyoming's Upper Green River Valley — are an important factor in attracting economic activity throughout the West.

BACK COVER, TOP: Public lands in the Rockies provide many places for family camping, such as alongside this Montana river.

MIDDLE: Mountain goats are found only in North America and are the largest animals to inhabit the high alpine regions of the Rockies.

BOTTOM: Breaking camp in Utah's canyon country.

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