GREATER SAGE-GROUSE MONITORING ON THE PINEDALE ANTICLINE PROJECT AREA

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2010 Annual Report

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INTRODUCTION

The wildlife monitoring and mitigation matrix (Matrix) appearing as Appendix B of the Pinedale Anticline ROD (U.S. Department of Interior 2008) states the following monitoring and effect size detection requirements (mitigation triggers) for greater sage-grouse populations in the Upper Green River Basin (UGRB) of southwestern Wyoming:

1. *Treatment lek activity overall and by lek complex*
   (30% change in the number of active treatment leks overall or by lek complex)
2. *Peak numbers of breeding males*
   (30% average change in the difference in the number of males documented on lek complexes between treatment and reference areas over 2 years)
3. *Nesting success*
   (15% average difference in nest success between treatment and reference areas over 2 years)
4. *Treatment female nesting habitat selection*
   (0.5 km average increase in infrastructure avoidance distance of females nesting in treatment areas over 2 consecutive years)
5. *Winter concentration area use*
   (15% average change in the difference of the amount of winter habitat used in treatment and reference areas over 2 years; and 30% average change in the difference of the numbers of grouse documented using treatment and reference areas over 2 years)
6. *Noise levels at leks*
   (10 dBA above background)

The mitigation triggers identified in #3 and #4 require radio-equipped female sage-grouse to successfully document. Wyoming Wildlife Consultants LLC (WWC) was retained by the Pinedale Anticline Project Office (PAPO) to conduct radio-telemetry on radio-equipped female sage-grouse during the 2010 nesting season and report findings. The following addresses each of the monitoring requirements identified above individually. Data from 2007-2010 are reported. We additionally address concerns raised by the Wyoming Cooperative Fish and Wildlife Research Unit (University of Wyoming, Laramie, WY, USA) as to the potential effectiveness of Matrix monitoring methodology.

1. TREATMENT LEK ACTIVITY OVERALL AND BY LEK COMPLEX

Field Methods:--Lek counts were conducted by employees with the Wyoming Game and Fish Department (WGFD) and the Bureau of Land Management (BLM). Lek count protocol followed standardized methods outlined by the WGFD's Sage-Grouse Technical Committee (Cheyenne, WY, USA; Christiansen 2007).

Analytical Methods:--Treatment lek complexes were identified by the WGFD, and included Duke's Triangle, Mesa, and Yellowpoint (see Figure 1). Sage-grouse lek count data from the UGRB (2007-10) as the maximum number of males counted per lek per year were supplied to WWC by the WGFD.

We considered leks active if ≥1 male was documented during counts; inactive leks were those where 0 males were documented. The percent change in the total number of active leks overall and by complex was calculated by subtracting the previous year's number of active leks from the subsequent year's number divided by the previous year's number. The overall number of active leks was calculated by adding across the 3 treatment complexes.

Results:--Overall percent change in the number of active leks in treatment complexes was 0% in 2008, -18.8% in 2009, and +7.7% in 2010.

YEAR	TOTAL ACTIVE LEKS	**% CHANGE**
2007	16	
2008	16	**0.0**
2009	13	**-18.8**
2010	14	**7.7**

Percent change in the number of active leks by treatment lek complex was: Duke's Triangle +50.0% in 2008, -66.7% in 2009, and +100% in 2010; Mesa was unchanged 2007-2010; Yellowpoint -12.5% in 2008, -14.3% in 2009, and 0.0% in 2010.

COMPLEX	YEAR	TOTAL ACTIVE LEKS	**% CHANGE**
Duke's Triangle	2007	2	
Duke's Triangle	2008	3	**50.0**
Duke's Triangle	2009	1	**-66.7**
Duke's Triangle	2010	2	**100.0**
Mesa	2007	6	
Mesa	2008	6	**0.0**
Mesa	2009	6	**0.0**
Mesa	2010	6	**0.0**
Yellowpoint	2007	8	
Yellowpoint	2008	7	**-12.5**
Yellowpoint	2009	6	**-14.3**
Yellowpoint	2010	6	**0.0**

Conclusions:--The mitigation trigger identified for the *Treatment lek activity overall and by lek complex* monitoring requirement was a 30% change in the number of active treatment leks overall or by lek complex. The mitigation trigger was met in 2009 for the Duke's Triangle lek complex; the number of active leks within this complex declined 66.7% between 2008 and 2009. Changes in the number of active leks overall or by the Mesa or Yellowpoint lek complexes did not meet the mitigation trigger levels.

Recommendations:--Continue to monitor lek activity as initiated. We suggest that those analyzing impacts in the future categorize leks into treatment and reference based on distance to natural gas field disturbance (leks within 6.4 km of infrastructure considered treatment leks; see Naugle et al. 2010). We additionally recommend that either ground or aerial lek searches be conducted on a regular basis (e.g., every 2 to 3 years) to document spatial shifts in lek locations (see Connelly et al. 2003 for methodology). For example, Mud Hole State, Waterhole

Draw, and South Rocks were discovered following the onset of development of the Jonah Field. If these leks became occupied near the time of discovery, then an accurate assessment of the number of active leks within an area would require these situations be regularly documented.

2. PEAK NUMBERS OF BREEDING MALES

Field Methods:--Lek counts were conducted by employees with the Wyoming Game and Fish Department (WGFD) and the Bureau of Land Management (BLM). Lek count protocol followed standardized methods outlined by the WGFD's Sage-Grouse Technical Committee (Cheyenne, WY, USA; Christiansen 2007).

Analytical Methods:--Treatment and reference lek complexes were identified by the WGFD; treatment complex included Duke's Triangle, Mesa, and Yellowpoint and reference complexes included Ryegrass, Speedway, and East Fork (see Figure 1). Sage-grouse lek count data from the UGRB (2007-10) as the maximum number of males counted per lek per year were supplied to WWC by the WGFD.

We considered the maximum number of males documented on a lek as the number of breeding males breeding on the lek, and calculated the number of breeding males by complex by adding the maximum number of males documented on all leks within the complex. We calculated the total number of breeding males by treatment and reference by adding across complexes. A 2-year average total population by treatment and reference was calculated by averaging numbers for the given year and the previous year. We subtracted 2-year average treatment from 2-year average reference numbers to estimate the difference in the number of males documented. Percent change of the 2-year average difference in the number of breeding males was calculated by subtracting the previous year's difference from the subsequent year's difference divided by the previous year's difference. It is worth noting that negative changes in the difference given these techniques suggest a decline of a given percentage in the difference (e.g., total treatment population is more similar numerically to the reference population between 2-year averages compared).

Results:--The difference between the 2-year average number of males in treatment populations compared to reference populations decreased by 4.7% in 2008-09 and 13.1% in 2009-10.

YEAR	REFERENCE Area Total Population	TREATMENT Area Total Population	2-Year Average REFERENCE Total Population	2-Year Average TREATMENT Total Population	2-Year Average Difference	**2-Year Average % Change**
2007	1852	859				
2008	1604	748	1728	803.5	924.5	
2009	1529	623	1566.5	685.5	881	**-4.7**
2010	1136	511	1332.5	567	765.5	**-13.1**

Conclusions:--The mitigation trigger identified for the *Peak numbers of breeding males* monitoring requirement was a 30% average change in the difference in the number of males documented on lek complexes between treatment and reference areas over 2 years. The mitigation trigger for the number of breeding males was not met in either 2009 or 2010.

Recommendations:--Continue to count the number of males breeding on leks as initiated. We suggest that those analyzing impacts in the future categorize leks into treatment and reference based on distance to natural gas field disturbance (leks within 6.4 km of infrastructure considered treatment leks; see Naugle et al. 2010). We additionally recommend that either ground or aerial lek searches be conducted on a regular basis (e.g., every 2 to 3 years) to document spatial shifts in lek locations (see Connelly et al. 2003 for methodology). For example, Mud Hole State, Waterhole Draw, and South Rocks were discovered following the onset of development of the Jonah Field. If these leks became occupied near the time of discovery, then an accurate assessment of the number of breeding males within an area would require these situations be regularly documented.

3. NESTING SUCCESS

Field Methods:--Female sage-grouse were captured on and near leks from mid-March through April by spot-lighting and hoop-netting (Giesen et al. 1982, Wakkinen et al. 1992). Females were classified as yearlings (first breeding season) or adults (≥second breeding season) based on the shape of the outermost wing primaries (Eng 1955). Radio transmitters were secured to females with a PVC-covered wire necklace (Advanced Telemetry Systems Inc. [ATS], Isanti, MN, USA). Transmitters weighed either 19.5 g or 22 g and had battery life expectancies of 530 and 789 days, respectively; all transmitters were equipped with motion-sensors (i.e., radio-transmitter pulse rate changed to indicate mortality). WWC and KC Harvey Soil & Water Resource Consulting (Bozeman, MT, USA) captured females used to estimate nest success in the UGRB 2006-10. The data used to estimate 2006-08 nest success were collected by WWC monitoring females for a Wyoming Community Foundation, UGRB Local Sage-grouse Working Group, and North American Grouse Partnership project being conducted in regions in the UGRB west of the Green River. The data used to estimate 2009 nest success were collected by KC Harvey monitoring females for the PAPO monitoring project and by WWC monitoring females for a project being conducted by the University of Wyoming (UW) in northern portions of the UGRB. The data used to estimate 2010 nest success were collected by WWC monitoring females for the PAPO monitoring project and the UW project. We added females monitored for other projects in the 2009 and 2010 nest success estimates to bolster sample sizes; we include 2006-08 nest success estimates for reference.

We used hand-held receivers and 3-element Yagi antennas (ATS) to monitor radio-equipped females at least every 48 hours through pre-laying (April) and nesting (May-June). Nests of radio-equipped birds were located by circling the signal source until females could be directly observed. After nest identification, incubating females were monitored from a distance of ≥60 m to minimize chances of human-induced nest predation or nest abandonment. Nest fate (successful or unsuccessful) was assigned when long-range radio monitoring indicated the female had left the area. Nests were identified as successful if ≥1 egg hatched as indicated by presence of detached eggshell membranes (Wallestad and Pyrah 1974), or if the female was documented incubating a nest for ≥35 days. We monitored unsuccessful females every 48 hours for 7 days following nest failure to detect re-nests.

Analytical Methods:--We used the lek of capture to categorize females into treatment and reference populations. Apparent nest success for treatment and reference populations was estimated as the number of successfully hatched nests divided by the number of confirmed nesting attempts. A 2-year average nest success by population was calculated by averaging the number of successful nests and the number of confirmed nesting attempts for the given year and the previous year and dividing. The 2-year average difference in nest success between treatment and reference populations was calculated by subtracting the reference estimate from the treatment estimate.

Because of low sample sizes, re-nests were not considered independently and were grouped with initial nests for annual nest success estimation. Nests of females killed during incubation where the eggs were not disturbed, and nests abandoned as a result of research activities, were not considered in nest success estimation because the fate of these nests was unknown. Because we typically identified a nest following the initiation of incubation (i.e., following clutch completion) and we potentially missed nests destroyed during the egg-laying or early incubation stages (females classified as non-nesters), nest success may be overestimated.

Results:--2-year average apparent nest success estimates for treatment populations was 7.5% higher compared to reference populations in 2009-2010.

Year	Number Nests TREATMENT	Number Successful Nests TREATMENT	Number Nests REFERENCE	Number Successful Nests REFERENCE	2-Year Average Number of Nests TREATMENT	2-Year Average Number of Successful Nests TREATMENT	2-Year Average Number of Nests REFERENCE	2-Year Average Number of Successful Nests REFERENCE	2-Year Average Nest Success TREATMENT	2-Year Average Nest Success REFERENCE	**DIFFERENCE**
2006			40	15							
2007			44	28			42	21.5		51.2	
2008			14	3			29	15.5		53.4	
2009	65	29	59	28			36.5	15.5		42.5	
2010	33	15	40	9	49	22	49.5	18.5	44.9	37.4	**7.5**

Conclusions:--The mitigation trigger identified for the *Nesting success* monitoring requirement was a 15% average difference in nest success between treatment and reference areas over 2 years. The mitigation trigger for nest success was not met in 2010.

Recommendations:--We suggest using the radio-equipped sample to estimate all demographic parameters (e.g., nesting propensity, nest success, early brood chick survival, fledge estimates, and adult survival) so that population growth can be ascertained. WWC collected the data necessary to address this recommendation in 2010, and on a project being conducted by UW on the same study area in 2009 because these data are critical to effectively managing sage-grouse. To reduce annual monitoring costs, we suggest reducing sample sizes of the number of radio-equipped females radio-tracked annually (1 technician can effectively track 35-45 radio-equipped individuals; M. Holloran, personal observation). Additionally, given that the goal of this monitoring objective is to quantify the effect of energy development on the probability of sage-grouse nest success, we recommend that variables known to influence success are standardized across treatment and reference populations. For example, areas in the western portions of the Ryegrass reference area contain habitats that differ from those found in the 3 treatment areas (e.g., mountain versus Wyoming big sagebrush habitats). Examples of variables identified in the literature as influencing the fate of sage-grouse nests include: herbaceous understory condition, hen age, distance from lek to nest, and nest densities (Niemuth and Boyce 1995, Connelly et al. 2000, Holloran and Anderson 2005).

4. TREATMENT FEMALE NESTING HABITAT SELECTION

Field Methods:--Female sage-grouse were captured on and near leks from mid-March through April by spot-lighting and hoop-netting (Giesen et al. 1982, Wakkinen et al. 1992). Females were classified as yearlings (first breeding season) or adults (≥second breeding season) based on the shape of the outermost wing primaries (Eng 1955). Radio transmitters were secured to females with a PVC-covered wire necklace (Advanced Telemetry Systems Inc. [ATS], Isanti, MN, USA). Transmitters weighed 22 g and had battery life expectancies of 789 days; transmitters were equipped with motion-sensors (i.e., radio-transmitter pulse rate changed to indicate mortality). WWC and KC Harvey Soil & Water Resource Consulting (Bozeman, MT, USA) captured females used to estimate infrastructure avoidance distance in the UGRB 2009-10. The data used to estimate 2009 nest to infrastructure distances were collected by KC Harvey monitoring females for the PAPO monitoring project and by WWC monitoring females for a project being conducted by the University of Wyoming (UW) in northern portions of the UGRB. The data used to estimate 2010 distances were collected by WWC monitoring females for the PAPO monitoring project and the UW project. We added females monitored for other projects in the 2009 and 2010 distance estimates to bolster sample sizes.

We used hand-held receivers and 3-element Yagi antennas (ATS) to monitor radio-equipped females at least every 48 hours through pre-laying (April) and nesting (May-June). Nests of radio-equipped birds were located by circling the signal source until females could be directly observed.

Analytical Methods:--Pad center points were digitized in NAD 1927 UTM Zone 12N at 1:10,000 scale using 2009 Sublette County Aerial Imagery purchased from the Sublette County Planning Office. All pads were checked against the spot_papa_18sep09_natcolor_utm12nad27 Aerial Imagery before digitizing a center location. All pads with discernable edges received center point locations, regardless of their proximity to other wells. No differentiation was made between wells and pump stations or other infrastructure, and every disturbance that had the appearance of a pad was marked with a center point. No differentiation was made between very large multiple well pads and smaller single well pads. When necessary, disturbances were zoomed as close as needed to assess the presence of facilities in order to prevent the marking of pads that had not yet become active or had already been reclaimed. Final center-point locations were projected from NAD 1927 to NAD 1983 UTM Zone 12N using the NAD_1927_to_NAD_1983_NADCON Geographic Transformation in order to make the data compatible with the grouse data.

We used nest location to identify treatment females; all females nesting within the Mesa, Duke's Triangle or Yellowpoint complexes as identified in Figure 1 were included as treatment individuals. The distance (m) from each nest to the nearest pad center-point was calculated in Excel. A 2-year average avoidance distance was calculated by averaging the distances from the given and previous year. The 2-year average difference in avoidance distance was calculated by subtracting the previous year's estimate from the given years. Nests of unknown fate (e.g., abandoned as a result of research activities) were considered selected nest locations; re-nests were not considered in the nesting habitat selection analysis due to a lack of spatial independence.

Results:--A change in the 2-year running average of avoidance distances cannot be calculated until 2012.

Year	Average Nest to Infrastructure Distance (km)	2-Year Average Nest to Infrastructure Distance (km)	**DIFFERENCE**
2009	2.46		
2010	2.07	2.33	**N/A**

Conclusions:--The mitigation trigger identified for the *Treatment female nesting habitat selection* monitoring requirement was a 0.5 km average increase in infrastructure avoidance distance of females nesting in treatment areas over 2 consecutive years. We cannot address this mitigation trigger without an additional year's worth of data.

Recommendations:--We suggest using the radio-equipped sample to establish seasonal habitat selection (e.g., nesting, early brood-rearing, late brood-rearing/summer, and winter) so that avoidance during other seasonal periods can be ascertained. WWC collected the data necessary to address this recommendation in 2009 and 2010 because these data are critical to effectively managing sage-grouse. To reduce annual monitoring costs, we suggest reducing sample sizes of the number of radio-equipped females radio-tracked annually (1 technician can effectively track 35-45 radio-equipped individuals; M. Holloran, personal observation). Additionally, because avoidance inherently implies a choice has been made, we suggest that the spatial scale of interest to address changes in avoidance distance be truncated to the area where females potentially choose to avoid infrastructure.

5. WINTER CONCENTRATION AREA USE

The information required to investigate the mitigation trigger for *Winter concentration area use* are being collected by the WGFD; these data were not made available to WWC.

Recommendations:--It is our understanding that the WGFD is conducting aerial surveys for wintering sage-grouse where flocks are identified and categorized by size, different-sized flocks are buffered by different-sized circular buffers, and that the regions depicted by dissolved buffers are considered winter concentration areas. We suggest that the buffers being used to identify the amount of area a flock of sage-grouse is using be based on field-verified data. We additionally suggest that winter telemetry flights locating radio-equipped birds be used to complement and verify accuracy of the aerial survey efforts.
For example, telemetry information could be used to investigate flock and habitat characteristics necessary for sage-grouse detection during survey flights (e.g., what is the proportion of small versus large flocks that are missed during survey efforts; are sage-grouse easier to detect in areas with sparse versus dense vegetation, and what are the detection differences; etc?).

6. NOISE LEVELS AT LEKS

The information required to investigate the mitigation trigger for *Noise levels at leks* are being collected by the WGFD; these data were not made available to WWC.

Recommendations:--We suggest that researchers versed in the use of noise-monitoring equipment and the techniques suited to analyze digital recordings be retained to conduct the monitoring required to address this mitigation trigger. Dr. Skip Ambrose with the Sandhill Company (Castle Valley, UT, USA; skipambrose@frontiernet.net) and Dr. Gail Patricelli with the University of California-Davis (Davis, CA, USA; gpatricelli@ucdavis.edu) are both renowned experts in the field.

WYOMING COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT REVIEW

It is interesting to note that many of the concerns raised through the WY-Coop review were also raised by WWC and Western EcoSystems Technologies (Cheyenne, WY, USA) in 2008 when responding to the initial call for proposals to monitor sage-grouse on the Pinedale Anticline.

The WY-Coop review identified essentially 3 areas of concern associated with the lek monitoring objectives: (1) lek searches are required in addition to counts of males on known leks; (2) a temporal component needs to be added to the analyses; and (3) sample sizes need to be large enough to generate statistically valid results. We also recommend conducting regular lek searches throughout the monitoring areas (see above recommendations). For the lek activity objective, our reading of the change required to trigger mitigation established a 1-year temporal component; a decline of 30% in the number of active leks across all treatment complexes or within 1 treatment complex would trigger mitigation. For the lek count objective, our reading of the change required to trigger mitigation established a 2-year temporal component; a decline of 30% in the number of males counted in treatment complexes as standardized by the number of males counted in reference complexes as averaged across 2 years would trigger mitigation. The methods used in this report we believe in a simplistic way (e.g., no modeling) address the temporal concerns raised in the WY-Coop review. However, the addition of lek searches to monitoring methodology to ensure all leks are counted within treatment and reference areas is required for accurate 1-year and 2-year results. It is our understanding that those monitoring leks for the Matrix monitoring effort are attempting to count every male using every lek within treatment and reference areas (e.g., a census verses a sample); if this is the case then sample sizes are not a concern (there is no sample being collected). Again, lek searches are required for an accurate census.

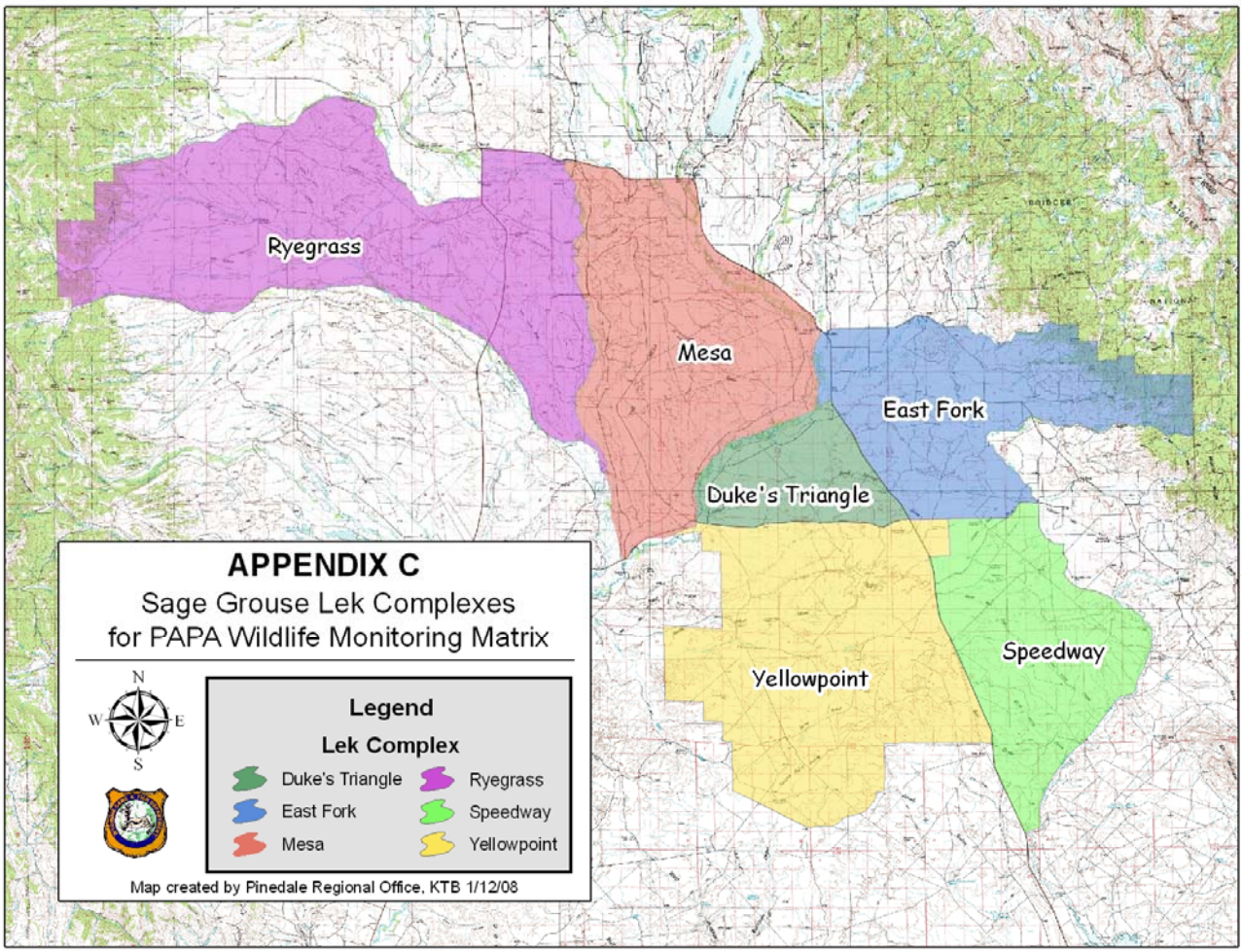
The WY-Coop review of the nest success and brood habitat use monitoring objectives is not applicable given that these objectives are not being pursued by the PAPO as of January 2011.

The WY-Coop review identified essentially 2 areas of concern associated with the winter concentration area monitoring objectives: (1) annual variation relative to winter severity needs to be accounted for; and (2) the precision of the estimates of winter use areas needs to be improved. The first concern simply requires that winter habitat use be monitored through several winters of different severity. We also recommend increasing the precision of the estimates of the area used by a sampled flock (see above recommendations).

We are not qualified to address the noise monitoring objective (see above recommendations).

FIGURES

Figure 1. Sage-grouse complexes for PAPO mitigation matrix monitoring as outlined by the WGFD. The Ryegrass, East Fork and Speedway complexes are considered reference areas; the Mesa, Duke's Triangle and Yellowpoint complexes are considered treatment areas. Figure from WGFD project RFP.



LITERATURE CITED

Christiansen, T. 2007. Chapter 12: Sage Grouse (*Centrocercus urophasianus*). *In*: Handbook of Biological Techniques. 3rd Edition. S. A. Tessmann, ed. Wyoming Game and Fish Department (WGFD), Cheyenne, Wyoming, USA.

Connelly, J. W., K. P. Reese, and M. A. Schroeder. 2003. Monitoring of greater sage-grouse habitats and populations. College of Natural Resources Experiment Station Publication No. 979, University of Idaho, Moscow, ID, USA.

Connelly, J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. Wildlife Society Bulletin 28:1-19.

Eng, R. L. 1955. A method for obtaining sage grouse age and sex ratios from wings. Journal of Wildlife Management 19:267-272.

Giesen, K. M., T. J. Schoenberg, and C. E. Braun. 1982. Methods for trapping sage grouse in Colorado. Wildlife Society Bulletin 10:224-231.

Holloran, M. J., and S. H. Anderson. 2005. Spatial distribution of greater sage-grouse nests in relatively contiguous sagebrush habitats. Condor 107:742-752.

Naugle, D. E., K. E. Doherty, B. L. Walker, M. J. Holloran, and H. E. Copeland. 2010. Energy development and greater sage-grouse. Studies in Avian Biology: *In Press*.

Niemuth, N. D., and M. S. Boyce. 1995. Spatial and temporal patterns of predation of simulated sage grouse nests at high and low nest densities: an experimental study. Canadian Journal Zoology 73:819-825.

U.S. Department of Interior. 2008. Record of decision, final supplemental environmental impact statement for the Pinedale anticline oil and gas exploration and development project Sublette County, Wyoming. United States Bureau of Land Management, Document number BLM/WY/PL-08/029+1310, Pinedale, WY, USA.

Wakkinen, W. L., K. P. Reese, J. W. Connelly, and R. A. Fischer. 1992. An improved spotlighting technique for capturing sage grouse. Wildlife Society Bulletin 20:425-426.

Wallestad, R. O., and D. B. Pyrah. 1974. Movement and nesting of sage grouse hens in central Montana. Journal of Wildlife Management 38:630-633.