REVIEW OF SAGE-GROUSE MONITORING FOR THE PINEDALE ANTICLINE PROJECT AREA

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INTRODUCTION

On February 16, 2010, Dr. Matthew Kauffman convened a panel of scientists with extensive experience in greater sage-grouse (*Centrocercus urophasianus*) ecology and management to conduct a third party review of the Pinedale Anticline Project Area (PAPA) sage-grouse monitoring plans. The panel was chaired by Dr. Jack Connelly, Department of Idaho Fish and Game and included Dr. E.O. Garton, University of Idaho, and Dr. Terry A. Messmer, Utah State University. Dr. Kauffman initiated the process with a conference call on March 3, 2010 in which he provided guidance to the panel as to their charge. Subsequent to this conference call Dr. Kauffman provided a copy of the protocols used by the Wyoming Game and Fish Department (WGFD) to conduct sage-grouse lek counts and surveys. The panel members completed independent reviews of the documentation provided by Dr. Kauffman. These reviews were submitted to Dr. Connelly for compilation into this final report. The panel addressed the following question in their review:

Are the experimental designs and methods for monitoring changes in sage-grouse populations as described in the Wildlife Monitoring Plan adequate to detect changes in the criteria identified by the PAPA Wildlife Monitoring Matrix within a reasonable timeframe? If not, how can the proposed monitoring plans be modified or amended to improve the ability of the monitoring protocols to meet the objective of tracking the biological criteria identified in the Matrix and the PAPA Record of Decision (ROD).

EXECUTIVE SUMMARY

Leks

Lek counts are being conducted according to WGFD protocol. However, this monitoring goal calls for assessing the number of active leks. In the PAPA area WGFD indicates that unoccupied leks and suitable habitat are surveyed opportunistically and information can be provided by various sources. Conceivably, some leks that are presently monitored could disappear or move to areas that are not routinely checked. Thus it is possible that the number of active leks within the PAPA or reference area complexes could be underestimated using the present approach. Routine monitoring of all suitable habitats for leks should also be implemented under an

occupancy estimation framework such that statistical precision of estimates of active leks is obtainable. Moreover, the change requiring mitigation does not have a temporal component. Is the 30% decline calculated on a per year basis or is it cumulative over several years? If the change is calculated over some period of years then that temporal span should be defined. The current lek count procedure appears adequate to detect an average 2-year change of 30%. However, this technique has a drawback in that it may not be very sensitive to population changes unless the sample of leks is reasonably large. In total, the number of leks surveyed in the development and reference areas is likely adequate to reflect real change, but if the data are separated by lek complexes the number of leks within complexes may not be adequate. As an example, information provided to the panel indicates that there are only two leks in the Speedway reference area. One way to mitigate the drawbacks associated with this technique is to ensure the lek surveys and counts are conducted in a standard manner by experienced personnel. The WGFD lek survey and count protocols include a provision that counts and surveys could be conducted by non-agency personnel trained on the techniques. For the purposes of monitoring sage-grouse population trends in the PAPA treatment and references sites we recommend only WGFD personnel with experience in the area and techniques be used. To insure that adequate sample sizes for lek counts are obtained, any leks not counted should be treated as containing no breeding males for analysis purposes. In addition, sample sizes for lek censuses must meet requirements of insuring a 90% probability of detecting a 30% decline in number of males attending leks within 2 years by comparison to control leks outside of the treatment area where the comparison is conducted with an alpha of 10% (0.1 probability of rejecting null hypothesis of no decline when a decline of 30% below pre-development numbers actually occurred). If the variability in the data precludes a statistical comparison with such power to detect declines, then the PAPO should consider expanding the reference area (s) to include a larger number of leks.

Nest success

Because treatment and reference areas are adjacent to one another, sage-grouse hens using leks in one area may nest in the other area. Moreover, hens that re-nest may first nest in the area of the lek on which they were marked (i.e., PAPA or reference area) but re-nest in the other area. If either or both of these situations occurred then interpretation of nest success data as it relates to potential disturbance would be problematic. Because of their secretive nature and the relatively short time hens are associated with the nest during the laying period, it is often difficult to tell if a grouse is nesting when the bird is in the egg-laying phase. After losing its first clutch, a hen may take several days to revisit a lek and select another nest site. Following the hen’s selection of a site she may take another day or more to begin laying her second clutch. Thus, more than a week could easily pass between the hen losing her clutch and beginning her second clutch. It could take observers an additional week to detect nesting effort. Therefore a 7-day post evaluation to detect re-nesting by hens with predated nests is likely inadequate. Contractors should only capture and radio-collar hens from leks within the PAPA treatment and reference areas that are spatially separated by at least twice the average distance of lek-to-nest movements. Based on the published literature, a rule of thumb would be 5-6 km. If this is not possible and leks in the PAPA treatment and reference areas are relatively close then data from hens that use both PAPA treatment and reference areas during the breeding season should be censored when these data are analyzed. Nesting success should be modeled with sophisticated survival estimation methods using logistic regression or Cox's proportional hazards so that models including both categorical (cover type) and continuous (distance to disturbance)

predictors can be used to project consequences of development infrastructure and activities across the landscape occupied by sage-grouse.

Brood habitat use

Early brood rearing habitats are normally used by chicks until they are 4-7 weeks of age and are usually key habitats for sage-grouse but are apparently not accounted for in this monitoring approach. Given the low nest success so far reported, sample sizes of hens with broods may be fairly low and there is no indication regarding how observers will differentiate between hens with and without broods. Brood rearing does not extend into November (brood break-up usually occurs in September). Thus, observers are monitoring summer habitat use and fall/early winter use. Sampling effort of once per month is likely not adequate to truly assess habitat use and may result in lost birds and unknown mortalities. We recommend use of early brood rearing habitats and late brood rearing habitats be evaluated separately. To determine if radio-collared hens that hatched nests are also brooding, we recommend occasionally flushing the hens. Broods can be flushed at 4-6 weeks of age. We further recommend separating brood rearing habitat from summer/fall habitat in the analysis and increasing sampling efforts to a minimum of 4 times per month.

Winter distribution

The winter distribution of sage-grouse often changes, sometimes dramatically, depending on winter conditions. Three to five or more years may be needed just to identify "normal" movements and there appears to be no pre-development data available. Thus, these data should be interpreted cautiously until sage-grouse have been monitored over enough years that a "norm" can be defined and normal variation in habitat use with respect to winter severity can be assessed. Recording the number of birds associated with each radio-collared sage-grouse will improve the precision of the estimates of winter use area by applying weighted use area estimates analogous to weighted home range estimates. The approach that will be used to estimate number of sage-grouse wintering in these areas in order to detect a 30% decline as specified in the matrix should be clearly described.

Noise level monitoring

The edge of the lek may change within and between years, and this should be defined and accounted for. Moreover, a lek has many edges because it is largely defined as a polygon, making it necessary to define and standardize which edge is to be measured. Additionally, it is not clear if all leks or just a few will be measured for noise. If a sample of leks will be used, how will the sample be selected? The approach to measuring noise appears to need some further thought. Areas that provide points for measurement should be carefully defined and all methods should be standardized to allow repeat measurements.

PANEL REVIEW PROCESS

The sage-grouse review panel provided an assessment and recommendations under five major subheadings: Leks, Nest Success, Brood Habitat Use, Winter Distribution, and Noise Level Monitoring. The panel first attempted to describe the monitoring methods used or planned. In the Lek section, much of this information reflects Wyoming Game and Fish Department protocols that are reasonably standard throughout the range of sage-grouse. This was followed by an assessment of the approach and recommendations for improvement. The panel reached overall consensus on all issues and agreed that the experimental designs and methods for monitoring changes in sage-grouse populations as described in the Wildlife Monitoring Plan are

generally not adequate to detect changes in the criteria identified by the PAPA Wildlife Monitoring Matrix within a reasonable timeframe.

LEKS

Lek Monitoring Protocols

Current methods of monitoring sage-grouse breeding populations recommended for use in PAPA are consistent with those used by WGFD. These methods include lek censuses (annually counting the number of male sage-grouse attending leks in a given area), lek complex routes (annually counting the number of male sage-grouse within a group [complex] of leks that are relatively close and represent part or all of a single breeding population), and lek surveys (annually counting the number of leks that are active in a given area). According to the protocols, all lek monitoring is to be done during early morning (1/2 hour before to 1 hour after sunrise), under reasonably good conditions (calm to light wind, partly cloudy to clear), from early March to early May. Appropriate ranges of survey dates depend on the elevations at which leks are found and the persistence of winter conditions.

The following definitions were adopted by the WGFD and reflect established protocols relied on for PAPA monitoring efforts:

- Lek. A traditional courtship display area attended by male sage-grouse in or adjacent to sagebrush dominated habitat. A lek is designated based on observation of two or more male sage-grouse engaged in courtship displays. New leks must be confirmed by a survey conducted during the appropriate time of day, during the strutting season. Sign of strutting activity (tracks, droppings, feathers) can also be used to confirm a suspected lek.

- Lek Complex. A group of leks in close proximity between which male sage-grouse may interchange from one day to the next. A specific distance criterion does not yet exist.

- Lek Count. A census technique that documents the actual number of male sage-grouse observed attending a particular lek or lek complex.

- Lek Survey. A monitoring technique designed primarily to determine whether leks are active or inactive. Obtaining accurate counts of males attending is secondary.

- Annual status – Lek status is assessed annually based on the following definitions:

    - active – Any lek that has been attended by male sage-grouse during the strutting season. Acceptable documentation of grouse presence includes observation of birds using the site or signs of strutting activity.

    - inactive –Any lek where sufficient data suggests that there was no strutting activity throughout a strutting season. Absence of strutting grouse during a single visit is insufficient documentation to establish that a lek is inactive. This designation requires documentation of either an absence of birds on the lek during multiple (3+) ground visits under ideal conditions (4/1-5/7, no precipitation, light

or no wind, ½ hour before to 1 hour after sunrise) **or** a ground check of the exact known lek site late in the strutting season (after 4/15) that fails to find any sign (droppings/feathers) of strutting activity. Data collected by aerial surveys may not be used to designate inactive status.

- unknown – Leks for which status as active or inactive has not been documented during the course of a strutting season.

Additionally, based on its annual status, a lek may be assigned to one of the following categories for management purposes:

- occupied lek – A lek that has been active during at least one strutting season within the prior ten years. Occupied leks are protected through prescribed management actions during surface disturbing activities.

- unoccupied lek – (Formerly "historical lek".) There are two types of unoccupied leks, "destroyed" and "abandoned." Unoccupied leks are not protected during surface disturbing activities.

- destroyed lek – A formerly active lek site and surrounding sagebrush habitat that has been destroyed and is no longer suitable for sage grouse breeding. A lek site that has been strip-mined, paved, converted to cropland or undergone other long-term habitat type conversion is considered destroyed. Destroyed leks are not monitored unless the site has been reclaimed to suitable sage-grouse habitat.

- abandoned lek – A lek in otherwise suitable habitat that has not been active during a period of 10 consecutive years. To be designated abandoned, a lek must be "inactive" (see above criteria) in at least four non-consecutive strutting seasons spanning the ten years. The site of an "abandoned" lek should be surveyed at least once every ten years to determine whether it has been reoccupied by sage-grouse.

- undetermined lek – Any lek that has not been documented active in the last ten years, but survey information is insufficient to designate the lek as unoccupied. Undetermined leks will be protected through prescribed management actions during surface disturbing activities until sufficient documentation is obtained to confirm the lek is unoccupied.

Observers use the following approach to assure counts are done consistently and accurately.

- Conduct lek counts at 7-10 day intervals over a 3-4 week period after the peak of mating activity. Although mating typically peaks in early April in Wyoming, the number of males counted on a lek is usually greatest in late April or early May when attendance by yearling males increases.

- Conduct lek counts only from the ground. Aerial counts are not accurate and are not comparable to ground counts.
- Conduct counts between ½ hour before sunrise to 1 hour after.
- Count attendance at each lek a minimum of three times annually during the breeding season.
- Conduct counts only when wind speeds are less than 8 kph (5 mph) and no precipitation is falling.
- Locate a spot that affords good visibility of the entire lek. If the lek is very large (100 or more birds) it may be necessary to select two or more vantage points. Be careful not to get so close that your presence disturbs the grouse.
- Record the time the count begins.
- Count the birds from left to right (or vice versa).
- Wait one to two minutes and then count from right to left.
- Wait one to two minutes and count from left to right again.
- Record the highest counts of male and female grouse separately, and then move to the next lek.

Lek Count Routes –

i. WGFD Rationale – A lek count route is a survey method designed to census a group of leks (a lek complex) that are relatively close and represent all or part of a single breeding population. Leks should be counted along routes to facilitate replication by other observers, increase the likelihood of recording satellite leks, and account for shifts in breeding birds if they occur.

ii. Application – Select routes such that all leks within a complex can be counted within 1.5 hours. If weather conditions deteriorate after a lek count route has begun, the route should be run again. If no birds are observed on a lek that was occupied in prior weeks or years, the observer should exit the vehicle and, with the engine off, listen for sounds of displaying grouse. Birds will sometimes relocate to a new lek site when they are subjected to continuing disturbance. If a predator flushes grouse from a lek, and it is still reasonably early in the morning, the grouse may resume displaying nearby once the predator leaves the area.

Before establishing lek routes in a given area, give some thought to the number of personnel available for conducting counts. It is much better to plan fewer counts yielding high quality data than to compromise data by scheduling more counts that personnel can reasonably handle. A responsible Department biologist or wildlife coordinator should assign lek counts and count routes. It is acceptable for persons from outside the agency to conduct counts, provided they are properly trained. Leks with the longest history of consistent data collection should be included in count routes, as these provide a basis for long-term trend assessment. At least one lek count route should be conducted in each management area occupied by sage-grouse.

Lek Status Surveys –

i. WGFD Rationale – Ideally, all sage-grouse leks would be counted annually. However, some breeding habitat is inaccessible during spring because of mud and snow, or the location of a lek is so remote it cannot be routinely counted. In other situations, topography or vegetation may prevent an accurate count from any vantage point. In addition, time and budget constraints often limit the number of leks that can be visited. Where lek counts are not feasible for any of these reasons, status surveys are the only reliable means to monitor population trends. Lek status surveys are designed principally to determine whether leks are active or inactive, requiring just a single visit to each lek. Obtaining accurate counts of the numbers of males attending is not essential. Status surveys involve substantially less effort and time than lek counts. They can also be done from a fixed-wing aircraft or helicopter. Because multiple visits are not required to determine peak attendance, leks that are not on count routes can be surveyed from the initiation of strutting in early March until early-mid May, depending on the site and spring weather.

   WGFD reports that this technique has a major drawback in that it is not very sensitive to population changes unless the sample of leks is very large. WGFD provides the following example: 50 males may be observed within a group of 5 leks during one spring survey and 75 males two years later. What appears to be a 50% increase may not be the case for a variety of reasons. The only legitimate interpretation of these results is that all 5 leks were active each year they were surveyed. However, on a very gross scale, lek survey data have been consistent with lek count data and population trends (up, down, stable) within Wyoming.

ii. Application – To obtain the most useful insight regarding population trends, conduct lek status surveys in the same manner, during the same time period each year. In other words, surveys should not be conducted from a fixed-wing aircraft one year and a helicopter the next year, or in early March one year and May the next. Record the date and time each survey is conducted. Also record UTM coordinates of each lek encountered, and note any other information that might later be considered important. Although it is difficult to accurately count birds from an aircraft, it is usually possible to estimate the number present.

If the exact location of a lek is known, its activity status can be checked any time of day and for a short period following the strutting season, based on presence of sign. Active strutting grounds characteristically have concentrations of scattered fecal pellets, feathers, tracks and trampled vegetation. In contrast, fecal deposits on winter ranges are typically discrete piles next to sagebrush. Strutting sites are also usually marked by large numbers of caecal droppings (miniature black “cow pies”). Caecal droppings are initially green, but cure to black quickly in the sun. Presence of green caecal droppings and fresh tracks indicate that a lek was active earlier in the morning. Fecal droppings can last for years, though they fade with time. On the other hand, caecal droppings usually decay within days or weeks, depending on precipitation, and this limits the time they are useful for documenting lek activity. Site visits also give observers an

ideal opportunity to precisely map the lek location by walking to its exact center and recording the coordinates with either GPS technology or orthophoto quad maps.

The ideal time for lek surveys is the same as for lek counts – about 1/2 hour before until 1 hour after sunrise. Under some conditions, sage-grouse will strut two hours or more after sunrise. Prolonged attendance usually coincides with: 1) presence of hens on the lek; 2) dim light conditions (overcast skies, fog, or light snowfall); or 3) the small, or "new" phases of the moon, when little strutting activity occurs at night. Males generally stop strutting early on mornings when hens are absent (late in the strutting season) or near the full moon, when much of the strutting and breeding take place at night. During the full and nearly full moon, sage-grouse may strut all night and males will occasionally initiate strutting at sunset or shortly after. At these times, leks can occasionally be checked in the evening. Lek surveys can be conducted at night during the full moon, provided leks can be approached closely enough to either hear or spotlight displaying grouse.

PAPA Leks Counts and Surveys – Panel Assessment and Recommendations

According to the information provided to the panel, biologists from the Pinedale WGFD Office will conduct annual lek counts on all active leks for the duration of the monitoring period. This monitoring will include 3 ground visits at 7-10 day intervals using the protocols previously presented. These counts will include all active leks within the treatment (PAPA) and reference area complexes as identified in the Pinedale Anticline Project Office (PAPO) monitoring contract. Based on our review and the information provided, we are assuming that biologists from the Pinedale WGFD will also conduct lek surveys on all known inactive leks annually to determine whether leks are active or inactive. According to the sage-grouse monitoring protocol, WGFD biologists will also visit the last known location and look for sign of recent activity. They also will search suitable habitat in surrounding areas to see if the lek may have moved. Obtaining accurate counts of males attending appears to be a secondary concern. These surveys appear to include all active and inactive leks within the treatment (PAPA) and reference area complexes identified in the PAPO monitoring contract. Unoccupied leks and suitable habitat are surveyed opportunistically and information can be provided by various sources including contractors, researchers, agencies personnel, and members of the general public. Any areas identified during these sightings as a likely lek are to be verified the next year.

Lek Surveys

The Wildlife Monitoring and Mitigation Matrix. This matrix indicates that identifying the number of active leks in identified lek complexes is a monitoring goal. The matrix further indicates that lek counts are to be conducted according to WGFD protocols. Changes to be monitored include active use on 70% of total current leks and active use on 70% of leks in each complex (the development area complexes include the Mesa, Duke's Triangle, and Yellow Point complexes) compared to 2007 data. The change requiring mitigation will be a 30% decline in total number of active leks, or 30% decline in the number of leks in a single complex.

Assessment. Lek counts are being conducted according to WGFD protocol. However, this monitoring goal calls for assessing the number of active leks. In the PAPA area WGFD indicates that unoccupied leks and suitable habitat are surveyed opportunistically and information can be provided by various sources. This approach suggests that leks could develop (or perhaps occur) in habitat that is not regularly or routinely monitored. Conceivably, some leks that are presently monitored could disappear or move to areas that are not routinely checked. Thus it is possible that the number of active leks within the PAPA or reference area complexes

could be underestimated using the present approach. A superior approach to analyzing lek surveys would be to apply occupancy estimation methods which make it possible to estimate a true proportion of leks occupied from single surveys by correcting estimates for probability of detecting activity from single visits.

Moreover, the change requiring mitigation does not have a temporal component. Is the 30% decline calculated on a per year basis or is it cumulative over several years? If the change is calculated over a single year then conceivably 29% of leks could be lost each year until no leks were left and mitigation would never be invoked. If the change is calculated over some period of years then that temporal span should be defined.

Recommendations. Define the temporal component associated with the monitoring goal as requiring mitigation if the number of active leks ever falls 30% below predevelopment number of active leks. Routine monitoring of all suitable habitats for leks should also be implemented under an occupancy estimation framework such that statistical precision of estimates of active leks are obtainable. This could be done using a stratified sampling scheme and sample sizes should be adequate to obtain a 90% probability of detecting a 30% decline in number of active leks with an alpha of 10% (0.1 probability of rejecting null hypothesis of no decline when a decline of 30% below pre-development numbers actually occurred).

Lek Counts

The Wildlife Monitoring and Mitigation Matrix. This matrix indicates that assessing peak numbers of males attending lek complexes is a monitoring goal. The matrix further indicates that lek counts are to be conducted according to WGFD protocol. Changes to be monitored include total average 2-year change in numbers of males attending development area lek complexes (the Mesa, Duke's Triangle, or Yellow Point lek complex) and these will be compared to the East Fork, Speedway, or Ryegrass reference lek complexes. The change requiring mitigation will be an average 30% decline in numbers over 2 years compared to reference area.

Assessment. Lek counts are being conducted according to WGFD protocol which is a reasonably standard approach used by most state agencies. The current procedure may be adequate to detect an average 2-year change of 30% if sample sizes of leks actually counted are adequate. However, this technique has a major drawback in that it is not very sensitive to population changes unless the sample of leks is very large or a very high proportion of the existing leks are counted.

Recommendations. There is some current discussion of revising lek count techniques and placing lek counts within a sampling framework (Garton et al. 2007). If techniques are revised, it would be important to maintain current methods throughout the period of the project to allow meaningful comparison among years and between areas. One way to mitigate the drawbacks associated with this technique is to ensure the lek surveys and counts are conducted in a standard manner by experienced personnel. The WGFD lek survey and count protocols include a provision allowing counts and surveys to be conducted by non-agency personnel trained on the techniques. For the purposes of monitoring sage-grouse population trends in the PAPA treatment and references sites we recommend only WGFD personnel with experience in the area and techniques be used. To insure that adequate sample sizes for lek counts are obtained, any leks not counted should be treated as containing no breeding males for analysis purposes. In addition, sample sizes for lek censuses must meet requirements of insuring a 90% probability of detecting a 30% decline in number of males attending leks within 2 years by comparison to control leks outside of the treatment area where the comparison is conducted with an alpha of 10% (0.1

probability of rejecting null hypothesis of no decline when a decline of 30% below pre-development numbers actually occurred). If the variability in the data precludes a statistical comparison with such power to detect declines, then the PAPO should consider expanding the reference area (s) to include a larger number of leks.

NEST SUCCESS

Monitoring of radio marked sage-grouse will follow the requirements outlined in the PAPO Request for Proposals (RFP). The monitoring protocols are to be robust enough to assess declines in nesting success or changes in nest site selection over a two year period. The RFP includes a requirement for nest monitoring at a minimum of 48-hour intervals beginning April 20 and continuing through the nesting period until all determinations of nest status are complete. For predated nests, a 7-day post evaluation will be used to assess re-nesting status. If a hen is re-nesting, monitoring will continue and nest success will be determined as described above. The contractor will capture and affix radio collars to sage-grouse hens only, and will attempt to collar both yearling and adult sage-grouse hens in the PAPA treatment and reference areas.

Nest Success Monitoring- Panel Assessment and Recommendations

The Wildlife Monitoring and Mitigation Matrix. This matrix indicates that monitoring will assess change in nesting success compared to reference areas, or change in nesting success and a concurrent change in habitat selection by nesting hens in relation to development disturbance. The PAPA matrix criteria for triggering mitigation actions include an "average of 15% per year decline over 2 years in nesting success compared to reference area." Additionally, a concurrent change of 0.5 km in habitat selection by nesting hens in relation to development disturbance and a concurrent change of an average of 15% per year decline over 2 years in nesting success compared to reference area will also trigger mitigation.

Assessment. A map provided the panel showing distribution of leks suggested that many leks within the PAPA and reference areas are in relatively close proximity and as such this may confound interpretation of data. Because treatment and reference areas are adjacent to one another, sage-grouse hens using leks in one area may nest in the other area because sage-grouse hens often make relatively large lek to nest movements (Wakkinen et al. 1992, Connelly et al. 2000). Based on the information provided, we do not know if sage-grouse hens in the PAPA and reference areas have a high incidence of re-nesting if their initial nesting attempt is unsuccessful. Hens that re-nest may first nest in the area of the lek on which they were marked (i.e., PAPA or reference area) but re-nest in the other area. If either or both of these situations occurred then interpretation of nest success data as it relates to potential disturbance would be problematic.

Because of their secretive nature and the relatively short time hens are associated with the nest during the laying period, it is often difficult to tell if a grouse is nesting when the bird is in the egg-laying phase. After losing its first clutch, a hen may take several days to revisit a lek and select another nest site. Following the hen's selection of a site she may take another day or more to begin laying her second clutch. Thus more than a week could easily pass between the hen losing her clutch and beginning her second clutch. It could take observers an additional week to detect nesting effort. Therefore a 7-day post evaluation to detect re-nesting by hens with predated nests is likely inadequate. Moreover, no mention is made of nest abandonment due to observer disturbance. This can be a relatively common occurrence. How will monitoring protocols address this issue if it occurs? Lastly, no mention was made of banding birds. This could provide additional data on movements and survival, especially if radios are lost or stop functioning.

In addition to changes in nesting success, one of the other mitigation triggers is a concurrent movement of 0.5 km in nesting habitat selection. We are unclear if the 0.5 km distance is from previous nest locations, leks, mapped nesting habitat, and/or the sources of disturbance? How will the contractor differentiate between an expansion versus abandonment of potential and occupied nesting habitats? Will changes in nesting habitat vegetation metrics also be assessed? The latter could be crucial as hens in response to increased disturbance may select nest sites which are suboptimal and as such increase predation risk.

Based on the information provided, we are assuming the nesting locations and vegetation characteristics of nests sites will be recorded, geo-referenced and plotted using Geographic Information Technology (GIS) and GIS layers created to track these changes relative to disturbances. These methodologies should be elaborated.

***Recommendations*.** To mitigate these concerns, contractors should only capture and radio-collar hens from leks within the PAPA treatment and reference areas that are spatially separated by at least twice the average distance of lek to nest movements. Based on the published literature, a rule of thumb would be 5-6 km. If this is not possible and leks in the PAPA treatment and reference areas are relatively close then data from hens that use both PAPA treatment and reference areas during the breeding season will not be assignable cleanly to either treatment or control group. Additionally, all captured birds should be leg-banded with unique numbers during the monitoring period.

We recommend the PAPO and subcontractor fully describe the specific protocols that will be used to quantify the effects of temporal (seasonal) and persistent (> two or more seasons) disturbance on sage-grouse hen nest site selection. These protocols should include data regarding the distance that individual sage-grouse were located from specific sources of disturbances. This analysis can be conducted using Thiessen polygons to determine if sage-grouse selected for habitats located further from sources of disturbance. Nesting success should be modeled with sophisticated survival estimation methods using logistic regression or Cox's proportional hazards so that models including both categorical (cover type) and continuous (distance to disturbance) predictors can be used to project consequences of development infrastructure and activities across the landscape occupied by sage-grouse.

BROOD HABITAT USE

According to the RFP, the contractor will document the locations of radio-collared sage-grouse on a monthly basis to determine habitat selection during the brood rearing period (July through November defined in the contract). Field personnel will track radio-marked grouse to determine habitat selection during the brood rearing period. Tracking will take place in both the PAPA and reference areas.

Brood Habitat Use Monitoring- Panel Assessment and Recommendations

The Wildlife Monitoring and Mitigation Matrix. This matrix indicates that monitoring will assess concurrent change in habitat selection by nesting hens in relation to development disturbance. However, there is no similar discussion regarding brood habitat selection or use. The PAPA Matrix criteria for triggering mitigation actions for nest site selection include a 0.5 km increase in avoidance distance per year over 2 consecutive years.

Assessment. Early brood rearing habitats are normally used by chicks until they are 4-7 weeks of age (Connelly et al. 2000) and are usually key habitats for sage-grouse but are apparently not accounted for in this monitoring approach. Given the low nest success so far reported, sample sizes of hens with broods may be fairly low and there is no indication regarding how observers

will differentiate between hens with and without broods (just because a hen hatched a clutch does not necessarily mean she has chicks). Brood rearing does not extend into November (brood break-up usually occurs in September). Thus, observers are monitoring summer habitat use and fall/early winter use. Sampling effort of once per month is likely not adequate to truly assess habitat use and may result in lost birds and unknown mortalities.

The assessment of brood habitat use can be further complicated if brood mixing (Dahlgren 2009) occurs. This may occur in areas where peak sage-grouse densities coincide with limited availability of brood rearing habitat. Given the relative proximity of the leks in the PAPA and references areas and the potential for brood mixing to occur cannot be overlooked. Additionally, the availability and quality of brood rearing habitat has been related to brood movement distances. In areas where brood rearing habitats are marginal, broods may engage in longer distance movements. The greater the distance moved, the higher the risk of predation.

Recommendations. We recommend use of early brood rearing habitats and late brood rearing habitats be evaluated separately. To determine if radio-collared hens that hatched nests are also brooding, we recommend occasionally flushing the hens. Hens can be flushed by an experienced observer who then carefully and systematically searches the flush site for the presence of chicks. A preferred method to locate chicks is to use experienced pointing dogs (Connelly et al. 2003, Dahlgren 2009). Broods can be flushed at 4-6 weeks of age. We further recommend separating brood rearing habitat from summer/fall habitat in the analysis and increasing sampling effort to a minimum of 4 times per month. When flushing broods, the relative size of the chick observed or flushed should be recorded. If a brood appears to consist of different size chicks, this observation may suggest an incidence of brood mixing.

The distance broods travel between flush points should be recorded and plotted. At each flush point, we recommend percent shrub and herbaceous (grass and forb) cover be recorded using standard techniques. Shrub and herbaceous cover plant height and visual obstruction readings at the flush point should be evaluated using a Robel pole. These data will allow the PAPO to determine if habitat qualities of brood rearing locations in the PAPA differ from the reference area.

WINTER DISTRIBUTION

Change in winter concentration area use will be compared to a reference area (once initial data are available), and a concurrent change in the total average 2-year numbers of males attending development area lek complexes (The Mesa, Duke's Triangle and Yellow Point lek complex) will be compared to the reference area lek complexes (East Fork, Speedway, and Ryegrass lek complex).

Winter Distribution Monitoring- Panel Assessment and Recommendations

The Wildlife Monitoring and Mitigation Matrix. This matrix indicates a change in winter concentration area use will be compared to reference area (once initial data is available); a concurrent change in the total average 2-year numbers of males attending development area lek complexes and reference area lek complexes will be assessed.

Assessment. The winter distribution of sage-grouse often changes (Beck 1977, Connelly et al. 2003), sometimes dramatically, depending on winter conditions. Three to five or more years may be needed just to identify "normal" movements and there appears to be no pre-development data available. Locating wintering use areas will require marking both males and females from development and control areas and sample sizes must be adequate to identify potentially numerous wintering use areas for birds occupying different portions of both development and

control areas. Relocating marked animals throughout the winter must be adequate to obtain estimates of winter use areas for individual birds as well as for sub-populations of birds wintering together in limited areas.

Recommendations. Sample sizes of radio-marked birds must be adequate to obtain estimates of winter use areas sufficiently precise to detect a 15% decline per year over 2 years with 90% probability when performing the test at an alpha of 10%. Recording the number of birds associated with each radio-collared sage-grouse will improve the precision of the estimates of winter use area by applying weighted use area estimates analogous to weighted home range estimates (Samuel, M.D., and E.O. Garton. 1985). Clearly specify the approach that will be used to estimate number of sage-grouse wintering in these areas in order to detect a 30% decline as specified in the matrix. Potential methods to consider should conform to standard distance estimation approaches or to mark-resight methods applicable to winter surveys of the wintering habitat delineated with radio-marked birds. Interpret these data cautiously until sage-grouse have been monitored over enough years that a "norm" can be defined and normal variation in habitat use with respect to winter severity can be assessed.

NOISE LEVEL MONITORING

Decibel levels at the lek more than 10 dBA above background will be measured from the edge of the lek (background = 39dBA per 2000 ROD, pg 27), and assessed with respect to a concurrent average of 30% change in peak numbers of male birds over 2 years.

Noise Level Monitoring- Panel Assessment and Recommendations

The Wildlife Monitoring and Mitigation Matrix. This matrix indicates that noise levels will be assessed and noise levels above background combined with a concurrent change in the total average 2-year numbers of males attending development area lek complexes (the Mesa, Duke's Triangle, or Yellow Point lek complex), compared to the East Fork, Speedway, or Ryegrass reference lek complexes will be considered to impact peak lek use by male sage grouse.

Assessment. The edge of the lek may change within and between years. How will this be defined and accounted for? Also, a lek has many edges because it is largely defined as a polygon so which edge will be measured? Additionally, it is not clear if all leks will be measured for noise or just a few. If a sample of leks will be used, how will the sample be selected?

Recommendations. The approach to measuring noise appears to need some further thought. Areas that provide points for measurement should be carefully defined and all methods should be standardized to allow repeat measurements. The sampling design for noise measurement sites must provide a basis for projecting noise impacts across the entire development and adjacent control areas. Such a design will require modeling sound projection from disturbance sites as a function of readily mapped landscape characteristics such as distance, terrain shape (roughness and concavity), etc.

LITERATURE CITED

Beck, T. D. I. 1977. Sage grouse flock characteristics and habitat selection during winter. Journal of Wildlife Management 41:18-46.

Connelly, J. W., K. P. Reese, and M. A. Schroeder. 2003. Monitoring of greater sage-grouse habitats and populations. University of Idaho College of natural Resources Experiment Station Bulletin 80. Moscow, ID.

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 28:967-985.

Dahlgren, D. K. 2009. Greater sage-grouse ecology, chick survival, and population dynamics, Parker Mountain, Utah. Dissertation, Utah State University, Logan, UT.

Garton, E. O., D. D. Musil, K. P. Reese, J. W. Connelly, and C. L. Anderson. 2007. Sentinel lek routes: an integrated sampling approach to estimate greater sage-grouse population characteristics. Pages 31-42 *in* K. P. Reese and R. T. Bowyer, editors, Monitoring populations of greater sage-grouse. University of Idaho, College of Natural Resources.

Samuel, M.D., and E.O. Garton. 1985. Home range: A weighted normal estimate and tests of underlying assumptions. Journal of Wildlife Management 49:513-519.

Wakkinen, W. L., K. P. Reese, and J. W. Connelly. 1992. Sage grouse nest locations in relation to leks. Journal of Wildlife Management 56:381-383. Experiment Station Bulletin 88. Moscow, ID.