July 8, 2010 (revised September 28, 2010 – submission deadline extended)

NWCC Grassland/Shrub Steppe Species Sage-grouse Research Collaborative *Protocols for Assessing Impacts of Wind Energy Development on Greater Sage-grouse* Request for Proposals Responses due: October 8, 2010

TO: Interested Parties

FROM: NWCC Grassland/Shrub Steppe Species Sage-grouse Research Collaborative ("Collaborative") Oversight Committee

RE: Request for Proposals to implement studies using *Protocols for Assessing Impacts of Wind Energy Development on Greater Sage-grouse*

INTRODUCTION

The Collaborative has developed research protocols to identify key questions to be addressed, preferred approaches to address these questions, and issues likely to be encountered by scientists studying impacts of wind energy development on sage-grouse (see Attachment A). The goal of the Collaborative's support of research is to determine the effects of wind power development[1] on seasonal distribution, habitat use, and vital rates of sage-grouse. The Collaborative distinguishes the difference between site-specific monitoring studies and research – this RFP is tailored to a comprehensive research effort and these protocols are not expected to be applied to all proposed wind energy projects.

The research protocols are intended to be replicated in several areas with different sagebrush communities and for migratory and non-migratory sage-grouse populations using a Before-After/Control-Impact (BACI) study approach. Post-construction study designs may also be considered. The Collaborative will coordinate study results into a comprehensive analysis of impacts across sage-grouse range, and ensure peer-review of studies is completed and outreach of results is conducted.

[1] Including turbines, meteorological towers, guyed wires and short haul transmission within the annual home range of sage grouse being studied.

RESPONDING TO THIS REQUEST

There are three options for engaging in this comprehensive research effort. Research teams can partner with wind developers that have planned or have existing sites that meet established site selection criteria (as described in Attachment B) and:

1. Submit a proposal to conduct studies using established Collaborative protocols and request *full funding from the Collaborative*.
2. Submit a proposal to conduct studies using established Collaborative protocols and request *partial funding from the Collaborative*.
3. Submit a proposal to conduct studies independently *(e.g., fully funded by the project proponent/partners)* but use established Collaborative protocols and contribute preliminary and final results to the Collaborative to help build the body of science.

Research proposals considered by the Collaborative will be evaluated based on their abilities to adhere to the ideal protocol and site selection criteria as outlined in Attachments A and B.

Interested parties shall provide:

- A 1-page cover letter
    - Proposed research team
    - Proposed study site, including partnership with wind developer
    - Budget, including total requested from Collaborative and any matching funds
- Description of how the project team will utilize the research protocols described in Attachment A including identification of any confounding variables and how to address them.
- Confirmation letter from developers of a qualified study site (criteria outlined in Attachment B) confirming partnership with project team to conduct studies and contribution of matching funds, if any.
- Detailed work plan and timetable of tasks and deliverables.
- Total budget including breakdown of labor and other direct expenses.
- Description of prior experience with this type of project and conformance of the project team with the desired qualifications listed below in this RFP.
- Current curriculum vitae (CV) for each member of the project team.

Party(s) selected will be required to submit a preliminary progress report of research results to the Collaborative at the end of the first year of study (December 31, 2011). In addition, researchers are expected to submit quarterly reports to the Collaborative and participate on quarterly conference calls with the Collaborative’s Oversight Committee to monitor the project’s progress.

- At the end of the research project, a first draft of the final research results shall be submitted to the Collaborative.
- Responses to comments from the Collaborative Oversight Committee and selected “technical experts” shall be provided within 60-90 days of the receipt of the comments.
- A second draft will be reviewed by the full Collaborative Oversight Committee and selected “technical experts”.

Responses to the next iteration of Collaborative’s comments shall be provided to the Collaborative and the third and final draft will be submitted for peer review within 30 days of receipt of the comments.

Respondents should submit an electronic version of their proposal and related supporting documents via e-mail in Microsoft Word or Adobe Acrobat PDF format to Jennifer Bies (jbies@kearnswest.com) for receipt by the close of business (5:00 pm PT) on October 8, 2010. Incomplete submissions will not be considered. We expect to respond to applications within 60 days.

Expenses Related to Offeror’s Submission - This solicitation document does not commit RESOLVE, the NWCC or any of the funding entities to pay any costs incurred in the submission of a proposal or in making necessary studies or designs for the preparation thereof. Submissions will not be returned to the submitter unless requested in writing.

Unnecessarily Elaborate Proposals - Submissions need not be excessively elaborate. Elaborate artwork, expensive paper and bindings, and expensive visual and other presentation aids are not necessary and are discouraged.

Telegraphic, Facsimile - This solicitation document does not allow the submittal of telegraphic proposals or facsimile proposals.

QUALIFICATIONS

Desired qualifications of respondents include:

- Demonstrated experience in research on sage-grouse, with emphasis on analysis of anthropogenic impacts;
- Strong writing ability and strong organizational skills;
- Demonstrated ability to produce on time, and work within a budget;
- Ability to work in a neutral and unbiased manner with parties representing a cross section of interests;
- Credibility with the various sectors represented on the NWCC including demonstrated capacity for maintaining a high level of objectivity and balanced viewpoint.

A submission review committee of technical research experts will review the proposals and recommend how the Collaborative Oversight Committee should proceed. Proposals will be evaluated and ranked based on the following criteria.

REVIEW CRITERIA

- 50% - research approach:
    - Quality of proposed approach
    - Project implementation
    - Project management plans
    - Adherence to protocols as outlined in Attachment A
    - Evidence of ability to conduct the work including any pre-construction data

- 25% - confirmation of partnership with developer of a qualified study site including:
  - Description of site
  - Timeline for project development
  - Size of project
  - Letter of commitment from developer allowing access to the project site
  - Letter of commitment from land owners or land management agency allowing access to property to conduct research
  - Letters of commitment concerning availability of existing data from proposed site
- 15% - strong credibility of the research team:
  - Demonstrated experience of key personnel
  - Demonstrated ability to work in collaborative setting, especially with NWCC sectors
  - Demonstrated ability to complete work on time and within budget
- 10% - project cost:
  - Letters of commitment from funding partners
  - Total budget, including matching funds
  - Cost proposal, by year
  - Cost effectiveness

Initiation of this research project is contingent on obtaining adequate funding. Research proposals with matching dollars or contributions from partnerships (including wind developers and others) are strongly encouraged. The Collaborative has limited research funds available; therefore, those who cost share will have an advantage in the evaluation process.

Be advised that the Collaborative operates on a consensus basis. This means that our report review process may be more time consuming due to the need to reach consensus within the Collaborative. The Collaborative will be looking for, among other things, a qualified individual(s) or team(s) that offer the best plan to meet the project objectives with input from all stakeholder groups represented on the Collaborative.

The Collaborative retains the right to award this project contract to a group of bidders, or parts of this project contract to several bidders, to not award any contract, and/or to re-solicit full proposals. The Collaborative also reserves the right to negotiate a final study design before funding is awarded. Awards will be subject to a contract agreement between RESOLVE, on behalf of the NWCC, and/or independent funding entities and the proposer(s), as well as the terms and conditions from the funding agency for this work, the U.S. Department of Energy.

Questions concerning this request for proposals should be submitted via email to Jennifer Bies, Facilitator for the Collaborative, (jbies@kearnswest.com) by July 22, 2010. Answers to all questions received by the established deadline will be posted to the NWCC website (http://www.nationalwind.org/sagegrouse.aspx) by August 5, 2010.

Attachment A: Research Protocols for Assessing Impacts of Wind Energy Development on Greater Sage-grouse

Purpose- The NWCC Grassland/Shrub Steppe Species Collaborative formed a Sage-grouse Research Collaborative (Collaborative). The Collaborative has embarked upon a multiple stakeholder, multiple agency, diversely-funded collaborative effort to coordinate research on wind energy development in sage-grouse habitat. The Collaborative's goal is to gain a better understanding about potential impacts on sage-grouse from wind energy development. These protocols are intended to assist in development of research methods and metrics to identify key questions to be addressed, preferred approaches to addressing these questions, and issues likely to be encountered by scientists studying impacts of wind energy development on sage-grouse. These protocols are intended to guide research projects designed to improve understanding of the impacts of wind energy facilities on sage-grouse, with the goal of guiding the siting and development of wind facilities to minimize impacts on sage-grouse. These protocols are not intended to guide pre-construction monitoring studies at all future wind developments.

Advantages and disadvantages of possible study designs are discussed. A full Before After Control Impact (BACI) design with five years of pre-construction data and at least five years of post-construction data that estimates fundamental demographic parameters and habitat selection over a distance gradient from wind facilities provides the strongest design. BACI controls should be as similar to the treatment site as possible (e.g., disturbance, vegetation cover, available habitat from landscape- to site-specific scale). Research proposals considered for funding by the Collaborative will be evaluated based on their abilities to adhere to the ideal protocol, described below.

Statistical Rationale- We believe that effective detection of impacts of wind energy facilities on local Greater Sage-grouse (hereafter sage-grouse) populations will depend on identifying responses of key demographic parameters to wind facilities. Population level response to wind facilities is of greatest concern to managers, but because indices of local population dynamics (i.e., lek counts) are subject to numerous sources of variation and bias, detection of responses by sage-grouse to wind facilities is likely to be most straightforward at the level of specific demographic parameters, such as seasonal survival or nest success. Lek counts, however, provide the only index of local density and, despite their limitations, must be part of any study of the impact of wind facilities. We have based the protocols below on these premises. We also are cognizant of recent research on sage-grouse, demonstrating substantial annual variation in demographic parameters at relatively small (e.g., 40 km) spatial scales. For example, annual survival of radio-tagged female sage-grouse varied from 0.75 to 0.60, and 0.45 to 0.50, over six years on two areas about 20 km apart (Blomberg and Sedinger 2009). Moynahan et al. (2006) report variation in annual survival from nearly 1.0 to about 0.50 across three years in Phillips County Montana; low survival was attributed to West Nile Virus. Sedinger et al. (2010) estimated that annual survival varied from 0.16 to 0.72 across population management units in Nevada and similar variation has been recorded in the Mono population (M. Farinha, University of Nevada Reno, unpublished). Substantial variation also characterizes nest success (Moynahan et al. 2007, Blomberg and Sedinger 2009, Kolada et al. 2009). Blomberg and Sedinger (2009) estimated that virtually all of the variation in lek counts over a five year period was the result of variation in male lek attendance rates, not actual dynamics of the local male population.

The substantial, and heretofore poorly understood, variation in key demographic parameters over short time frames (one to three years) and limited spatial scales (< 20 km) renders a classic BACI (Before After Control Impact) approach problematic for assessing impacts of wind energy development on sage-grouse under most realistic scenarios. BACI designs certainly represent the "gold standard" for assessment studies. We also believe that replication is a necessary component of the assessment of wind energy impacts. We, however, see two important limitations of the BACI approach for assessing impacts of wind energy on sage-grouse. First, it will often be difficult to collect more than two years of pre-construction data, given uncertainties in permitting, sighting and construction of wind facilities. The substantial spatial-temporal variation in important demographic parameters suggests that a minimum of five years of pre-construction data might be needed to characterize the pre-construction state of populations. Spatial variation and potential covariance among study sites makes it unlikely that replication of study sites can overcome this problem. Second, as the Western States Sage and Sharp-tailed grouse Technical Committee (WSTC) recommendations[2] suggest, ≥ four years may be required to detect post-construction impacts. We believe even this estimate is conservative, given the aforementioned spatial-temporal variation in demographic parameters, and the difficulty in acquiring adequate precision for annual parameter estimates. Consequently, a full BACI design will require a minimum of a decade (five years pre-construction followed by five years post-construction) to provide a reasonable probability of successfully assessing impacts of wind development.

Given the uncertainty about development of specific sites, a full BACI design may not be feasible in many cases. Three reasonable and acceptable alternatives to a full BACI design, which can provide useful data, include (1) a before-after (BA) design that relies on a distance gradient from wind facilities, rather than true control sites, to assess impacts; (2) an entirely post-construction study; or (3) a shorter pre-construction period of two years, followed by ≥ five years of post-construction research. All of these approaches have limitations, thus it is essential to understand potential limitations of the alternatives to a full BACI design.

The BA design depends on the assumption that impacts will be greatest nearer the development, and will diminish farther from the development. This kind of design, thus, compares patterns in demographic patterns near versus far from the development. If there are impacts, we expect steeper declines in demographic parameters (e.g., annual survival, nest success) near, versus far, from the development. Such a time X distance design can be easily incorporated into modern analyses. This approach has the advantage over entirely post-construction studies, or shorter pre-construction studies, because it can better detect complete displacement, resulting from construction

[2] Recommendations to the GS3C Sage-grouse Collaborative: Wind Energy Related Research Questions and Priorities with Some Suggestions for Possible Research Sites. Western States Sage and Sharp-tailed grouse Technical Committee dated January 25, 2010.

of wind facilities. The BA design also has one advantage over a full BACI design. It consolidates field work within some defined distance of the development. This distance is presently unknown but would likely be about 30 km (ca. 20 miles). A well defined and spatially limited study site has the additional advantages of reducing spatial heterogeneity in the study (although as pointed out above such heterogeneity may still be substantial), and reducing logistic costs. A significant potential disadvantage of time X distance designs is the lack of an identified control site and replication for individual developments. We believe these disadvantages relative to BACI designs can be reduced by using replication across multiple studies.

An entirely post-construction design also depends on the assumption that impacts will be greatest nearer the development, and will diminish farther from the development. For studies of the impact of anthropogenic development on sage-grouse this approach has at least one advantage over a BACI design; for a given amount of resources, it allows for longer post-construction monitoring, by eliminating collection of pre-construction data. A potential disadvantage of a post-construction design is the risk that all individuals are displaced from locations relatively near the development, which eliminates the gradient in impact this design depends on because no individuals near the development remain to be studied. Walker (2008) encountered exactly this problem in his assessment of coal bed methane development in northern Wyoming. Because no (or few) individuals remained near developments, such individuals could not be studied. Consequently, only individuals relatively distant from development facilities could be studied, and these individuals demonstrated relatively weak demographic responses to development because they were sufficiently removed from the impacts of development. In such cases, the displacement itself was the principal impact, and such displacement cannot be effectively studied using only a post-construction design.

Designs employing an abbreviated pre-construction period have the advantage over post-construction studies that they allow for assessment of pre-construction spatial distribution and habitat use. These data can be combined with post-construction relationships between demographic parameters and environmental variables (see below) to model effects of displacement if they occur. For example, if individuals are displaced from pre-construction areas containing 50% sagebrush land cover to areas containing 30% sagebrush land cover post-construction, the impact on seasonal survival nest success, or other demographic parameters could be predicted based on analyses of the relationships between demographic variables and habitat features arising from the post-construction data. Additionally, fates of the displaced individuals can be directly assessed post-construction.

We note that it will be important to assess the hypothesis that regional populations are actually impacted by development. For example, it is conceivably possible that if displacement occurs, such displacement merely increases density at a distance from developed sites, such that regional density is unaffected. For intensive development over large land areas it seems unlikely that displaced individuals could be “accommodated” in surrounding areas. For smaller point source developments, however, it will be necessary to assess the hypothesis that density did not increase at a distance from facilities sufficiently to compensate for declines near facilities. Lek counts provide the only feasible approach to this question.

Parameters to be estimated-The WSTC recommendations[3] addressed not only wind facilities themselves, but associated developments, like transmission lines. Based on current priorities of the GS3C Sage-grouse Collaborative, we restrict our recommendations to facilities immediately associated with wind generation itself, including access roads and short haul transmission. We, thus, do not address long distance transmission, although we recognize this as an important research need. With these restrictions in mind, we expand on recommendations 2, 3, 5, 7, 8 from WSTC's summary of prioritized research needs. Briefly, these recommendations address (1) effects of wind energy development on seasonal distributions, habitat use and vital rates of sage-grouse (recommendation 2), (2) identifying seasonal use areas outside the breeding season (recommendation 3), assessing how wind energy facilities affect predator species composition with associated effects on sage-grouse (recommendation 5), (4) developing consistent stipulations for "buffers" or "habitat protection areas" (recommendation 7), and (5) investigate better methods to monitor sage-grouse populations and lek counts (recommendation 8).

Anthropogenic structures are thought to affect sage-grouse directly by stimulating avoidance behavior or movement away from the development, and increasing mortality or nest failure rates (Braun 1998, Hall and Haney 1997). Such displacement could influence attendance of leks by males. Additional potential outcomes could include reduced nesting effort. Displacement from high quality habitats could indirectly affect adult survival, reproductive effort, and recruitment of juveniles. Indirect effects, operating potentially through changes in the predator community, could include reduced nest success, chick survival and adult survival. Additionally, displacement out of preferred habitats could include the entire suite of demographic parameters through changes in cover or nutritional condition. We believe that the recommendations provided by WSTC can be addressed in landscape level ($\geq$ 1 km scale) studies of the potentially affected demographic rates. These demographic rates include lek attendance rates and survival of males, survival and nesting rates of females, nest success and survival from hatch to recruitment. Seasonal habitat use and habitat used for nesting and rearing broods should be assessed at both site and landscape scales.

Methods-

Field methods- Estimating demographic rates requires adequate samples of individually marked animals. For assessment of wind energy impacts, sage-grouse should be captured and marked along a gradient of distance from wind facilities (turbines, short haul transmission and associated roads). Ideally, the gradient would extend from < 1 km to > 20 km away from facilities. Both males and females should be captured in association with leks along the gradient using standard procedures (Giessen et al. 1982, Wakkinen et al. 1996). We recommend a minimum of 50 females and 100 males be captured annually during spring. An additional sample of juveniles and adult females (25 of each) should be captured during late summer – early fall,

[3] Recommendations to the GS3C Sage-grouse Collaborative: Wind Energy Related Research Questions and Priorities with Some Suggestions for Possible Research Sites. Western States Sage and Sharp-tailed grouse Technical Committee dated January 25, 2010.

which may be best accomplished near water sources. The longer-term nature of this research will result in cumulative sample sizes that are substantially larger than annual minimums (i.e., most radios last > 2 years so with a 50% annual survival rate, a goal of 50 new females per year will result in the following sample sizes over 5 years: 50 in the first year and 75 in each subsequent year, for a total of 350 over a five-year period). The Collaborative acknowledges there may be challenges to meeting the minimum sample sizes at sites located outside of core areas. Proposals that meet the recommended sample sizes will have an advantage over those that do not, but researchers may submit a proposal that includes smaller sample sizes with an explanation of any limitations. All individual females captured during spring should be fitted with a uniquely engraved plastic band, a size 14 aluminum band and a necklace style radio transmitter (Walsh 2002, Doherty et al. 2008). All males should be fitted with a uniquely engraved plastic band and size 16 aluminum band (Walsh 2002). A subsample (25) of males should be fitted with radio transmitters for assessment of nonbreeding season habitat use. Individuals captured in fall should be fitted with radio transmitters and the appropriate sized aluminum bands. Individuals located multiple times per week will provide adequate samples for characterizing habitat use Cost of GPS radio transmitters and the potential trade-off between sample size (number of individuals marked) and detail available per individual when using GPS transmitters may not warrant use of GPS transmitters for studies like those we describe here. However, as long as the minimum annual sample sizes are met the researcher(s) can elect to use VHF or GPS transmitters.

During spring, marked females should be located at least twice weekly until concentrations of locations indicate that a female is attending a nest. The nest location should be identified visually. It is not necessary to flush the female for the purposes of assessing impacts of wind energy but if females are accidentally flushed it is possible to statistically account for such disturbances when estimating nest survival (Rotella et al. 2000). Once females are nesting, nest status should be checked 2-3 times weekly (without flushing females) until nests hatch or fail. Visits should be increased to daily as hatch nears. Leks should be monitored weekly throughout the lekking season, to record band codes for males, conduct lek counts and record disturbances at leks. We have found that band codes can readily be read from a blind located at a distance of 50 – 100 m using 20 – 60 X spotting scopes. After hatch, females with broods should be located weekly and brood size determined using flush counts. Broods should be followed until independence in late July. Nonbreeding adults and all other radio-tagged individuals should be located twice weekly. GPS coordinates should be recorded for all locations of radio-tagged individuals to support site specific and landscape level analyses of habitat use and the linkage between habitat variables and key demographic parameters. Each location should be accompanied by a random point, selected from within an area of the approximate size of the seasonal home range to allow the assessment of habitat selection. Because the sample of marked sage-grouse will be captured across a gradient extending outward from planned wind facilities, it will be possible to assess variation in habitat selection along this gradient, and associated relationships between demographic parameters and habitat features.

Standard procedures for measuring vegetation at nest sites should be employed at nest sites as well as all other sites where radio-tagged individuals are located and randomly selected points. These protocols are described in (Canfield 1941, Daubenmire 1959, Drut et al. 1994, Bureau of Land Management 1996, Connelly et al. 2003) and include line intercept estimates of total shrub cover and sagebrush cover along 20 m long transects. Percent cover of understory vegetation along with residual grass height should be recorded in Daubenmire plots placed along transects used to estimate shrub cover. At larger scales (up to several km) remotely sensed imagery provides the most effective method for assessing landscape level variables, such as proportion sagebrush landcover type within a given radius of used or random points.

Changes in abundance of avian predators can best be monitored using regular (e.g., weekly) counts on facilities (or in areas planned for development during pre-construction) and throughout the study area. Records of disturbance at leks by avian predators were correlated with counts of avian predators along a transmission line within 20 km of leks (Blomberg and Sedinger 2009). Mammalian predators could also respond to wind facilities if such facilities provide either shelter or anthropogenic food sources, or if wind-related bird fatalities provide an available food source below turbines. Although mammalian predator populations may change in response to wind development, mammalian predators are frequently nocturnal or crepuscular, and secretive and it can be difficult and expensive to monitor their populations. Therefore monitoring mammalian predator populations is not a requirement of these protocols.

Analyses-Site specific habitat variables (.e.g., shrub cover) should be summarized using standard methods (e.g., Holloran et al. 2005). Additionally, key landscape level habitat variables should be summarized for locations of radio-tagged sage-grouse. Points should be buffered for a reasonable distance (e.g., 100 m) and percent cover of landscape level vegetation variables such as percentage pinyon-juniper estimated. It may be appropriate to consider larger scale habitat features, such as percent sagebrush landcover within a 1 km circle. Alternatively, use of particular habitat types and variation in demographic rates among habitat types may be assessed at larger spatial scales. These latter analyses would be appropriate if response by sage-grouse to development is reflected in displacement from one major habitat type into another.

Essential features of the assessment of potential impacts of wind facilities are the direct linkage between presence of facilities and demographic parameters important to the stability of sage-grouse populations, or indirect linkages operating through displacement into less suitable habitats, which in turn affects demography. Modern maximum likelihood-based estimation approaches for data from marked animals provide the only scientifically justifiable approaches to address these questions. Such approaches offer the additional advantage that explanatory variables of interest, like distance from facilities or habitat variables can be directly incorporated into analyses. Thus, it is possible to directly estimate functional relationships between the direct or indirect impacts of wind facilities and sage-grouse demography and population dynamics, while statistically controlling for environmental variables, such as habitat features. These approaches should, therefore, be most informative. We discuss these analyses in the context of Program Mark (White and Burnham 1999), which is the most widely used software for analysis of data from marked animals. Alternative software exists, however, especially for known-fate and nest survival analyses (e.g., Rotella et al. 2004).

Seasonal and annual survival of adult females should be conducted using known fate approaches, such as those implemented in Program Mark. Recent examples include Moynahan et al. 2006, Anthony and Willis 2009, Sedinger et al. 2010). Site-specific and landscape level vegetation variables should be incorporated into these analyses as time-varying explanatory variables. These variables should include distance from wind facilities. Similarly, nest survival should be estimated using maximum likelihood approaches that allow direct incorporation of environmental covariates directly into models of nest survival. These approaches allow incorporation of additional explanatory variables (from the perspective of impact assessment) such as nest age, female age and nest initiation date.

Demography of females is typically thought to be most important for understanding dynamics of local sage-grouse populations. While this thinking is largely correct, it ignores the fact that populations of sage-grouse are monitored by counting males. Consequently, understanding demography of males is essential for interpreting lek dynamics. Additionally, the number of males displaying on leks may influence attractiveness of leks to breeding females (Gibson 1996), and dynamics of the male population could, therefore, indirectly influence dynamics of the female segment of a population. Capture mark recapture (CMR) methods should be used to assess annual survival of males, recruitment of males, rate of population increase (λ), probability of attending a lek and probability of movement among leks. All of these analyses can be performed in Program Mark. Pradel (1996) temporal symmetry models can be used to estimate annual survival, recruitment and rate of population increase for males on leks. Robust design models (Kendall et al. 1997) allow estimation of the probability that males attended a lek at some time during the lekking season. Multistate models (Brownie et al. 1993) can be used to estimate probabilities that males remain on a particular lek versus moving to another lek. All of these approaches allow incorporation of covariates.

Under a full BACI design demographic parameters (including movement, recruitment and λ) and pre- and post-construction should be compared controlling for distance from facilities and other environmental variables (e.g., landcover type). Expectation if facilities influence populations would be that at least one demographic parameter would change post versus pre-construction and change would be greatest near facilities. Under this scenario, adult survival, nest survival, recruitment, lek attendance or λ would be expected to decline, while movement would be expected to increase. Age-specific population models (Caswell 2001) can be used, combined with direct estimates of λ, to assess impacts on local population dynamics. Direct linkages between demographic parameters and environmental variables will improve understanding of the role that displacement into suboptimal habitats plays in negative impacts of wind facilities on local populations, and should improve prediction of such impacts in future development.

A post-construction study would employ a similar analytical strategy, except that rather than treating pre- and post-construction as fixed effects, investigators would use a time trend by distance interaction to assess impacts. The expectation, if impacts occur, would be greater decline in demographic parameters near facilities than farther away. A risk of this approach, is that all sage-grouse “near” facilities are completely displaced, making it impossible to acquire samples of marked individuals near development. Such complete displacement has made it difficult to assess mechanisms of impact in intensively developed areas of Wyoming and Montana (D. Naugle, University of Montana, personal communication).

The abbreviated pre-construction design is unlikely to produce reliable estimates of demographic parameters pre-construction for reasons described above. Abbreviated pre-construction designs would allow description of seasonal habitat use pre- and post-construction. Combined with post-construction models relating demographic variables to environmental variables (e.g., sagebrush cover) and population models, habitat use data allow model-based estimation of population dynamics (e.g., Aldridge and Boyce 2007) pre- and post-construction. Because population dynamics pre-construction are not directly estimated, inference about wind facility impacts will not be as strong as under a full BACI design. An additional advantage of a design incorporating abbreviated pre-construction sampling, versus no pre-construction monitoring, is that it may be possible to directly assess movement away from leks near facilities.

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Attachment B: Study Site Selection Criteria

1. Reasonable certainty that the project will be built within 5 years:
    - To avoid spending excessive periods of time in collection of pre-construction data.
    - To ensure necessary post-construction data can be collected.
    - Includes all sites with good potential for research and that meet the other site selection criteria regardless of the policy or land management restrictions.
    - All challenges to construction must be identified up front.
2. Evidence that a sufficient population of sage-grouse is present in close proximity to proposed turbine locations at the site.
    - Sufficient population: described in research protocols (see Field Methods, page A-4).
    - Close proximity: should be inclusive of the full range of assumed indirect impacts, which at this stage in Oregon and Idaho is 5 miles.
    - Sites may not have a large sage-grouse presence year round, but need to serve as seasonal habitat or nesting habitat etc. It could be a site with nearby active leks and the site is used seasonally for various purposes.
3. Replicated studies require a sufficient number of sites to accommodate for geographic diversity and data variability caused by seasonal weather anomalies (e.g. hard winter in western WY or ID vs. moderate winter in central WY or ID).
4. Need to determine if other large-scale anthropogenic activities that are known to impact sage-grouse (i.e., oil & gas and other wind development, etc) occur within approximately 11 miles of the site that might disrupt analysis of wind development effects. Avoid sites with these confounding factors or account for in study/analysis design.