Wildlife Protection Recommendations for Wind Energy Development in Wyoming

Approved By Wyoming Game and Fish Commission November 17, 2010

Much interest has been expressed in developing wind resources in Wyoming to provide renewable energy to western states, particularly California. The Wyoming Game and Fish Department (WGFD) is aware of nearly 30 new wind projects which are expected to seek regulatory approval in the next few years and we expect many additional proposals as new transmission projects enter the regulatory process. The Wyoming Infrastructure Authority, in conjunction with transmission developers, is currently studying a conceptual design capable of collecting as much as 12,000 megawatts (MWs) of new electric generation within the state. The majority of this new generation is expected to come from wind turbines. Currently, only about 1,000 MWs of wind-generated electricity is produced in the state.

The recommendations contained in this document are the result of a decision by the Wyoming Game and Fish Commission (WGFC) to address the need to protect wildlife resources while wind energy is developed in the state. The recommendations are a proactive step toward balancing Wyoming's desire to provide renewable energy to out-of-state consumers while affording adequate protection of the state's wildlife resources from activities associated with development of a wind industry.

APPLICABILITY

Ultimately, the authority to make land management decisions and approve individual wind projects rests with regulatory and surface management agencies other than WGFC and WGFD, based on principals of multiple use and sustained yield set forth by the Federal Land Policy and Management Act and the National Forest Management Act or based on impact avoidance and mitigation as set forth in the Wyoming Industrial Information and Siting Act and other state and county statutes and regulations. Neither WGFC or WGFD have regulatory authority to impose any of the recommendations contained in this document – our role is strictly consultative.

Most wind projects constructed in Wyoming, regardless of land ownership, will require a permit from the Wyoming Industrial Siting Council (WISC). W.S. 35-12-110 (b) requires WGFD to provide information and recommendations to the WISC regarding the impacts of industrial facilities (including wind projects, collector systems, etc.) subject to WISC jurisdiction and a specific recommendation as to whether the WISC should issue a permit. WGFD will use these recommendations as the basis of our consultative obligation to the WISC and in furthering our cooperating agency responsibilities under the National Environmental Policy Act (NEPA). These recommendations will also provide consistency during review of wind projects within WGFD. Except for Best Management Practice (BMP) 4, applicants may suggest site-specific alternative proposals for achieving the objectives of the BMPs outlined in Appendix A. The WGFD will consider the applicant's proposals as we develop project-specific recommendations if the applicant can demonstrate that the alternative proposal would achieve the same level of protection outlined in the Appendix A Best Management Practices (BMPs).

Because it is prudent to be as comprehensive as possible within this document, all of these recommendations (including the best management practices and monitoring recommendations) will not be applicable to all wind projects in the state and are intended to be applied based on specific characteristics of a project site determined during pre-construction surveys and in consultation with WGFD. Early consultation with WGFD is the best means available for developers to determine which recommendations are appropriate for their project area. Project developers should consult with the WGFD at least two years prior to submitting permit applications so that appropriate studies can be conducted and site-specific recommendations can be developed. Failure to consult with WGFD early will result in delays making specific recommendations to other agencies with regulatory authority.

PURPOSE AND USE OF THIS DOCUMENT

The major purposes of this document are to provide recommendations for: 1) collecting baseline data prior to turbine siting to avoid potential conflicts with wildlife; 2) construction and operations monitoring; and 3) mitigating impacts to affected wildlife. These recommendations apply to all lands within the state. This document provides guidance under the WGFC's Mitigation Policy (WGFC 2008) and supports the WGFC's Mission of "Conserving Wildlife – Serving People."

This document provides advanced disclosure of potential wildlife-related concerns, and suggests BMPs, planning considerations including avoidance, monitoring, research and mitigation opportunities wind developers and regulatory and land management agencies can incorporate into project siting, design, construction and operations to conserve wildlife. The recommendations should be applied based on site-specific characteristics of each project area through early consultation with WGFD. Maps of crucial big game winter ranges, sage-grouse habitat (including sage-grouse core areas), priority watersheds, and other important habitats are available from WGFD.

These recommendations were prepared by WGFD staff who reviewed and incorporated pertinent literature to identify and describe reasonably foreseeable impacts to wildlife resources (refer to literature cited). A number of studies have examined effects of wind energy operations on selected species primarily birds and bats. However, there is a large gap in known information for most other species. Where appropriate WGFD gathered and interpreted information for most other species. Where appropriate, WGFD gathered and interpreted information on disturbances and activities which we believe to be comparable to those associated with wind development. While we recognize the amount of disturbances (i.e. total land disturbance), types of facilities (i.e. producing wellhead, drill rig) and intensity of activities (i.e. level of operational traffic) associated with other types of development may be more or less than those associated with wind development, the response of wildlife to those other types of development provide a reasonable means of understanding how wildlife may react to the types of disturbances and activities associated with wind development. For example, we consulted studies of wildlife responses to oil and gas development, surface mining, humans on foot, ATVs, construction activities, roads, noise levels, etc. to generally understand and predict how wildlife would react to disturbance and activities associated with wind developments. The WGFD believes this approach, when combined with best professional judgment and field experience of WGFD biologists, affords a reasonable basis for impact avoidance, mitigation, monitoring and management recommendations contained in this document.

The state of knowledge regarding potential consequences of wind development to wildlife resources is limited. As such, we recognize and fully expect that new research, much of it likely conducted in Wyoming, will lead to the need to modify these recommendations. We welcome this new research and commit to maintaining these recommendations as a ‘living document” that reflects our current understanding of the response of all the state’s wildlife to wind development. We encourage input that may improve future revisions. Please direct comments to the Wind Recommendations Chairman, Scott Gamo, Wyoming Game and Fish Department, 5400 Bishop Boulevard, Cheyenne, WY 82006.

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STATEMENT OF PRINCIPLE

Potential and documented impacts of wind energy development on wildlife are a concern for wildlife population and habitat managers. In addition to the potential associated direct and indirect impacts from wind energy projects, development creates additional cumulative impacts on the landscape. Already, Wyoming has experienced impacts upon its wildlife populations from oil, natural gas, coal bed methane, coal, trona and other extractive industries. Large-scale wind development, pipelines, transmission and collector lines, potential oil shale development, and other intensive land uses can further industrialize and fragment the landscape across Wyoming resulting in site-specific and cumulative impacts to wildlife.

If public and private lands are to remain in a condition that sustains wildlife and outdoor recreation, it is imperative that all forms of energy be developed with the least possible disturbance and that the integrity and functionality of important habitat areas be maintained. This document provides recommendations to achieve these goals for wind development through a variety of project planning, siting, design, monitoring and mitigation considerations.

INTRODUCTION

Wind energy is an important component in the nationwide effort to reduce the effects of global warming associated with carbon-based fuels. Wind development in the U.S. increased by 46% in 2007, and at the end of 2007 the U.S. had the second highest cumulative wind generation capacity globally. This rate of development is expected to accelerate, as U.S. energy policy emphasizes reduction of carbon emissions. The Federal Advisory Committee on Wind (FAC) concluded that wind-generated electrical energy, from a global warming perspective, has environmental benefits including to wildlife.

Wind energy development produces electricity without air pollution, greenhouse gas emissions, significant water consumption, mining, drilling, refining, waste storage and other problems associated with many traditional forms of energy generation – all of which may result in benefits to wildlife. The U.S. Department of Energy (DOE) estimates that a single 1.5 MW wind turbine displaces 2700 metric tons of CO2 per year compared with the current U.S. average utility carbon-based fuel mix. Due to these advantages, wind is expected to play an increasingly important role in meeting the Nation's energy needs in the coming years.

In July 2003, the U.S. Fish and Wildlife Service (USFWS) issued "Voluntary Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines." The Department of the Interior also convened a 22 member Wind Turbine Guidelines Federal Advisory Committee (FAC), which reached consensus on a set of draft recommendations aimed at minimizing the impacts of land-based wind farms on wildlife and its habitat. The interim guidelines are not mandatory requirements in Bureau of Land Management (BLM) land use plan decisions. Until the Secretary determines the applicability of final FAC guidelines for the Department of the Interior (DOI) agencies, the USFWS interim guidelines are only to be used as a general guide to assist the BLM in siting decisions and the design of pre-construction surveys, mitigation measures, and post-construction monitoring for individual projects. WGFD has reviewed the FAC draft document and has developed our recommendations to fall within the broad guidelines contained within the latest version (Version 6, 2010).

REVIEW OF WIND DEVELOPMENT IMPACTS TO WILDLIFE

Wind development is an intensive, industrial-scale use of the land surface. Individual wind project boundaries vary in size ranging from just a few turbines on a few hundred acres upwards to 1000 or more turbines distributed across 80,000 to 100,000 or more acres. With current technology, individual turbines typically generate in the range of 1.5-2.5 MWs. Towers range from 212 to over 260 ft tall with blade sweeps of 328 ft to over 400 ft above ground level. Generally, tower height increases as generating capacity of individual turbines increase. Wind projects require a road network to facilitate access for construction and turbine maintenance. In addition, power lines (aboveground or buried) provide for the collection of electricity generated at individual turbines and delivery to substations. Collector lines connect substations at wind project sites to transmission hubs. All associated infrastructure has the potential to affect wildlife and habitat.

Wyoming has enviable diversity and abundance of wildlife. The state contains large expanses of relatively intact native ecosystems that provide the buffer necessary for animals to spatially accommodate natural or man-caused changes to their habitat. The WGFD considers loss of habitats and concurrent fragmentation of habitats as the principal concern when we evaluate potential perturbations to the landscape and the effect on wildlife species. Cumulative impacts, fragmentation of habitats, direct and indirect impacts all contribute to declines in species habitats and numbers. Although maintenance or improvement of habitat function is paramount in crucial habitats (crucial big game ranges, core sage grouse areas, etc.), the future functionality of these crucial habitats and the wildlife they support is dependent on maintaining adequate habitat connectivity across the state to ensure crucial habitat components within the state are not isolated from other crucial habitats through habitat fragmentation and construction of barriers. From this perspective, the WGFD has approached wind development as another potential impact on the state’s habitat capacity which is necessary to sustain wildlife found in Wyoming. The following sections provide greater detail of some of the potential conflicts with wildlife species and wind development in Wyoming. The Appendices outline our recommended approach to identifying, understanding and ultimately avoiding and minimizing the potential detrimental effects of wind projects on many of the wildlife species in Wyoming. Coordination with the USFWS’s Wyoming Ecological Services Field Office, is also important for all wind development and can help ensure compliance with Federal laws.

BATS

Wind energy developments can impact resident and migratory bats depending on site location and the species that are present. Four types of impacts are anticipated: 1) direct mortality due to collisions with turbines; 2) direct mortality resulting from rapid decompression of lungs due to changes in atmospheric pressure caused by bats passing through the rotating turbine blades; 3) indirect impacts due to displacement of bats from preferred feeding, roosting, and mating areas; and 4) indirect impacts due to alteration of migratory pathways. Additional research is required to further determine impacts to bats.

There is concern that impacts to bats from wind turbines are underestimated (Arnett 2006, Kunz et al. 2007a, Arnett et al. 2008). Because bats are small, nocturnal, and cryptic, bats are often overlooked during carcass searches, making it difficult to assess mortality accurately. Moreover, until recently, mortality surveys were aimed primarily at assessing the impacts to avian species and often failed to incorporate adequate methods to locate bats into their study design. As such, these early efforts likely underestimated impacts to bats. Researchers have hypothesized that the abundance of North American bats could be significantly reduced within the next 10 years if efforts are not undertaken to minimize turbine impacts to bats (Kunz et al 2007b).

Of the 18 bat species found in Wyoming. Almost half have been identified in turbine-related mortality assessments conducted throughout the U.S. (Johnson 2005, Arnett et al. 2008). Most of the turbine-related bat fatalities tend to occur in August and September, which appears to coincide with the migration of several species. Most of the bats killed by turbines tend to have similar life history characteristics (Johnson 2005, Arnett et al. 2008). Although all bats may have some level of susceptibility to turbine-caused mortality, in studies conducted to date, tree roosting bats, eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), and silver-haired bat (*Lasionycteris noctivagans*) comprise the majority of carcasses located during ground searches and appear to be most susceptible (Johnson 2005, Kunz et al 2007b, Cryan and Brown 2007,). Other species that are known to be susceptible are the big brown bat (*Eptesicus* fuscus), Brazilian free-tailed bat (*Tadarida* brasiliensis), eastern pipistrelle (*Pipistrelle subflavus*), little brown bat (*Myotis lucifugus*), northern long-eared myotis (*Myotis septentrionalis*) (Johnson 2005). Hester and Grenier (2005) provide a complete list of bats known to occur in Wyoming and their ditribution.

Bat mortalities are not always the result of collisions. Researchers have recently discovered that collisions with wind turbines only accounted for about half of all mortalities at a wind energy facility in south-western Alberta, Canada. Necropsies of bats located during ground carcass searches revealed that nearly 90% of all bat mortalities included internal hemorrhaging caused by rapid decompression due to negative pressures created by rotating turbine blades (Baerwald et al. 2008). Known as Barotrauma, this internal hemorrhaging was reported to be the proximate cause of death for all bats that showed no external signs of fatal injuries.

Why bats are susceptible to fatality from turbines is poorly understood. Cryan and Brown (2007) hypothesized that turbines may be mimicking features on the landscape that bats are attracted to and may serve as rendezvous sites for migration or mating. Kunz et al. (2007b) developed an additional eleven hypotheses that could explain the reasons why insectivorous bats have fatal interactions with turbines. Cryan and Barclay (2009) have recently separated existing hypotheses into proximal and ultimate causes.

> "**Linear corridor hypothesis.** Wind energy development facilities constructed along forested ridgetops create clearings with linear landscapes that are attractive to bats.
>
> **Roost attraction hypothesis.** Wind turbines attract bats because they are perceived as potential roosts.
>
> **Landscape attraction hypothesis.** Bats feed on insects that are attracted to the altered landscapes that commonly surround wind turbines.

Low wind velocity hypothesis. Fatalities of feeding and migrating bats are highest during periods of low wind velocity.

Heat attraction hypothesis. Flying insects upon which bats feed are attracted to the heat produced by nacelles of wind turbines.

Acoustic attraction hypothesis. Bats are attracted to audible and/or ultrasonic sound produced by wind turbines.

Visual attraction hypothesis. Nocturnal insects are visually attracted to wind turbines.

Echolocation failure hypothesis. Bats cannot acoustically detect moving turbine blades or miscalculate rotor velocity.

Electromagnetic field disorientation hypothesis. Wind turbines produce complex electromagnetic fields, causing bats to become disoriented.

Decompression hypothesis. Rapid pressure changes cause internal injuries and/or disorient bats while foraging or migrating in proximity to wind turbines.

Thermal inversion hypothesis. Thermal inversions create dense fog in cool valleys, concentrating both bats and insects on ridge tops."

Preliminary information suggests that the fatalities of bats at wind energy development facilities may be predictable events following certain weather patterns (Cryan and Brown 2007, Arnett et al. 2008). Hoary bat migrations appear to be predictable events following nights with high cloud cover, low wind, and low barometric pressure. Other studies in the eastern U.S. support the conclusions of Cryan and Brown (2007) and reported that fatalities were higher on nights with light winds (Arnett et al. 2005, Arnett et al. 2008). Overcast nights and low barometric pressures are also consistent with observed migration patterns for passerine birds (Alerstam 1990), suggesting that both birds and bats migrate under similar conditions coinciding with the passage of cold fronts.

PASSERINES AND RAPTORS

An estimated 33,000 birds are killed annually in the U.S. by wind turbines and, according to a study by Smallwood (2007), this estimate may be biased low. This number contributes to cumulative impacts of all bird collision mortality in the U.S., e.g. collisions with telecommunications towers, collisions with moving vehicles, and collisions with structures. Out of the 33,000 birds killed annually, 26,600 are killed in California alone due to the sheer number of turbines and certain outdated turbine designs that are in place (Erickson et al. 2001). Outside of California, approximately 1.83 birds are killed per turbine per year (corrected for searcher efficiency and carcass loss to scavenging) (Erickson et al. 2001). As the number and height of wind turbines increase across the U.S., there may be a corresponding increase in the number of annual bird mortality figures (Mabey and Paul 2007).

Direct impacts to birds themselves include injuries or fatalities from collisions during flight with wind turbine rotor blades, monopoles, power lines, guy wires, and other related structures (Kunz et al. 2007a, Winegrad 2004). Most species of birds are at risk of collisions, although studies have shown that specific groups of birds in particular habitats, under certain weather conditions, or in large densities are more at risk than others, including raptors, migrating birds, wading birds, and waterfowl (Becker et al. 1999, Erickson et al. 2001, Rugge et al. 2003, Kingsley and Whittam 2007, Kuvlesky et al. 2007).

The design, placement, and layout of wind turbines can determine the vulnerability of birds to collisions, especially where species are more likely to collide with structures due to relative abundance, behavior, topography, and linkage with specific habitats (Erickson et al. 2002, Hoover and Morrison 2005, Kuvlesky et al. 2007, Rugge et al. 2003). For example, additional impacts to raptors are created when turbines are sited on steep slopes and hillsides, in canyons and draws, on ridge crests and peaks within canyons, and when rock piles that attract prey species are located near turbines (Hoover and Morrison 2005, Kingsley and Whittam 2003, Smallwood and Thelander 2004). Grassland birds that engage in aerial displays during courtship, such as the long-billed curlew, upland sandpiper, vesper sparrow, horned lark, chestnut-collared longspur, and McCown’s longspur, have a greater risk of colliding with rotor blades that occur within a male’s territory (Ehrlich et al. 1988, IDNR 2007, Fellows and Jones 2009).

Based on relative abundance, passerines comprise the majority of fatalities from wind turbines with newer designs (taller towers with larger rotor blades and slower rotor speeds), with the peak of fatalities occurring during migration (Erickson 2004). Migrants that funnel through a concentrated migration corridor or along landforms such as ridges, steep slopes, and valleys are more at risk of collisions if turbines also occur in these areas (Kingsley and Whittam 2003, IDNR 2007). Most night migrants fly between 300-2,000 feet (91-610 m), so the risk of collision is expected to increase as tower height and rotor diameter increase and tip speed decreases (Kerlinger 2004, Smallwood and Thelander 2004, Morrison 2006). Collision mortality estimates vary from site to site throughout the U.S. and are presently not thought to have a impact on populations of passerines (Erickson et al. 2002); however, bird collision fatalities from wind projects constructed in bird migration routes and corridors remain a justifiable concern (Erickson et al. 2005). Collision mortality of raptors, however, may impact populations due to the longer life span and lower reproductive potential of raptors compared to passerines (Kuvlesky et al. 2007). The most common fatalities of raptors at the Altamont Pass Wind Resource Area in California include the red-tailed hawk, burrowing owl, American kestrel, and golden eagle (Orloff and Flannery 1992, Thelander and Rugge 2000, Smallwood et al. 2007). The relative abundance of these species being struck by wind turbines was disproportionate to their frequency of fatality. Some species are apparently more susceptible than others to the risks posed by wind turbines (Thelander and Rugge 2000).

Direct impacts due to habitat loss, modification, and fragmentation from land use changes associated with wind development may render sites unsuitable for birds and may have the greatest adverse impacts to bird communities (Kuvlesky et al. 2007). Long-term impacts are caused by the cumulative footprint of the turbine towers, roads, power lines, and supporting infrastructure that removes or alters habitat, which displaces birds from preferred habitat, shifts birds to less desirable habitat, and causes birds to avoid impacted areas (Rugge et al. 2003, Smallwood and Thelander 2004, Strickland 2004).

Grassland songbirds are very sensitive to disturbance and fragmentation of grassland habitat and vertical structures within grassland habitat, particularly area-sensitive species such as the grasshopper sparrow, dickcissel, and bobolink that require large expanses of intact habitat (Leddy et al. 1999, Nicholoff 2003, IDNR 2007,). Studies have shown that habitat use by grassland passerines and prairie grouse was lower in study plots containing wind turbines than in study plots without turbines (Leddy et al. 1999, Johnson et al. 2000), with the actual distance depending on the species, and likely ranging from <330 feet (<100 m) to 2 miles (3 km) (Strickland 2004). In other studies, differences in breeding density for grassland species in relation to proximity to wind turbines varied by species, with some species appearing to be more sensitive to the turbines than others (O'Connell and Piorkowski 2006).

Research conducted in sagebrush-steppe habitat with dirt roads and a low volume of traffic showed that density of sagebrush obligate birds was reduced by 39-60% within a 328-foot (100 m) buffer around roads (Ingelfinger and Anderson 2004). This study raises concern about the impacts of roads created during industrial developments and the possibility that the presence of obligate species and area-sensitive species may decline if the habitat they require is removed or compromised. Roads are a direct cause of habitat loss and fragmentation, thereby reducing both habitat quantity and quality. An increase in roads will also increase bird-vehicle collisions and reduce native plant biodiversity by facilitating the introduction and spread of invasive plants and noxious weeds (Erickson et al. 2005, Kuvlesky et al. 2007).

Indirect impacts occur when habitat and landscape alterations disrupt foraging behavior, activities associated with breeding, and migration patterns (Kunz et al. 2007a). Studies have reported displacement effects that range from approximately 250-2,600 feet (75-800 m) away from wind turbines (Leddy et al. 1999, Strickland 2004). Large wind projects may also create a barrier along migration paths or between foraging and roosting areas, causing a behavioral shift in birds, avoidance of habitats associated with and adjacent to wind projects, and an increase in the amount of energy expended during movements (Winegrad 2004, Drewitt and Langston 2006). Birds may avoid habitat at and surrounding wind projects due to the presence of continuous motion and constant noise. Although not well studied, reports suggest that changes in wildlife behavior and habitat use may occur in response to shadow flicker, which is caused by sunlight passing through the rotating blades of wind turbines (IDNR 2007). Passerines that occur in open habitats may be most affected, as the rapidly moving shadow may resemble the flight of an aerial predator, causing both behavioral changes and an increased stress level (IDNR 2007).

Excessive or continuous noise can interfere with the vocal communication of birds, particularly during the breeding season (March through July for most raptors and April through July for most passerines). It is important to note that not all turbines are in operation 24 hours a day. Therefore, for the purpose of this document, "continuous noise" is noise that occurs while these facilities are in operation or while any residual noise is occurring (e.g. power lines). In addition, for the purpose of this document, "excessive noise" is noise that is detected by the listener above ambient noise levels (Rogers et al. 2006). Birds that rely on vocal cues to attract and retain mates and defend territories can be particularly sensitive to noise. Continuous noise produced by turbine engines and rotor blades and noises associated with substations, power lines, and routine maintenance (e.g. vehicular traffic, motorized equipment) may adversely affect territory selection and defense, foraging and fledging success, song learning, and dispersal (Nicholoff 2003). Excessive noise can also produce stress in individual birds, resulting in avoidance of impacted areas and lower population densities within impacted areas. The effects of continuous noise on bird communities are greatest where noise levels exceed 50 dBA; however, even moderate noise levels of 40 to 50 dBA may negatively impact bird communities (Nicholoff 2003).

Both direct and indirect impacts from wind development can contribute to increased mortality of birds; changes in food availability; nesting, roosting, and staging site availability; and an increased risk of predation (NRC 2007). These impacts can also result in a reduction in nesting density in a developed site, behavioral changes such as avoidance or abandonment of preferred habitat, and occupancy of marginal habitat. Ultimately, facility size and design and the areas in which turbines and other infrastructure are located will dictate the degree of impact that wind projects have on birds.

GREATER SAGE-GROUSE AND SHARP-TAILED GROUSE

In Wyoming, some of the most economically attractive wind development sites are often within native shrub or grassland ecosystems inhabited by greater sage-grouse (*Centrocercus urophasianus*), plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi) or Columbian sharp-tailed grouse (T.p. columbianus*). Wind development alters site characteristics through placement of tall structures (towers and power lines) and road networks (Braun 2006 and others). Prairie grouse did not evolve with these types of features in their environment. Older turbine designs produced noise levels well above the threshold of 49 dBA known to impact breeding birds (Ingelfinger 2001, Nicholoff 2003). For example, overall noise levels measured during a moderate wind day at the Altamont Pass Wind Energy Project were about 70 dBA (Dooling 2002). New turbine designs produce less noise. Turbines also produce motion and project moving shadows onto the ground. These types of habitat alterations may cause impacts to prairie grouse and a variety of other wildlife adapted to treeless environments. Sage-grouse were determined to be "*warranted but precluded*" for listing under the federal Endangered Species Act by the USFWS (March 2010) and Columbian sharp-tailed grouse have been petitioned for listing twice.

Several planning documents and environmental analyses have noted that peer-reviewed studies specific to prairie grouse are lacking and additional research is needed to determine if anticipated impacts are occurring and to what degree (USFWS 2003, Manville 2004, Governor's Sage-Grouse Conservation Team 2004, Sharp 2005, Strickland 2005, Stiver et al 2006:5-1, Southwest Wyoming Sage-grouse Working Group 2007:38, Bates Hole/Shirley Basin Sage-grouse Working Group 2007:74). Mabey and Paul (2007) observed, "The most common studies about the impact of wind facilities on birds in grassland and shrub-steppe habitats document mortality at specific facilities. This is not unexpected; most studies are commissioned by wind energy companies to determine potential and actual mortality to satisfy regulatory concerns. Thus far, regulators seem to be concerned primarily, if not exclusively, with mortality. A much smaller set of studies document behavioral responses (e.g., changes in flight behavior) or effects on breeding bird density or distribution." Strickland (2004:34) stated, "Indirect loss of habitat may occur from birds' behavioral responses to development, such as avoiding wind plant facilities and areas surrounding them. Long-term habitat impacts result from the construction of relatively permanent structures that remove habitat for the life of a project and from birds avoiding habitat disturbed by a wind farm and not habituating (i.e., becoming accustomed) to wind farm features." Strickland (2005) recommended a *Before-After Control-Impact* (BACI) sampling design to evaluate non-fatality impacts when it is possible to collect pre-construction data.

Although wildlife resource agencies have identified a critical need to conduct studies documenting avoidance effects and changes in population demographics associated with wind development, such studies have not been widely done. This is particularly problematic for sage-grouse, which are highly sensitive to disturbances and habitat modifications.

Due to the lack of specific wind related research, studies of other developments involving similar infrastructure components and disturbances provide some insight into the impacts of wind development on prairie grouse (Manville 2004, Strickland 2004, Sharp 2005). For example, studies examining the impacts of roads, power lines, communication towers, and noise in natural gas fields are relevant in ascertaining how native prairie grouse are likely to respond to wind development. Movement and noise associated with turbines and road traffic, in particular, are expected to cause some level of avoidance based on similar avoidance effects observed at large-scale natural gas development (see Lyon 2000; Lyon and Anderson 2003). But specific research is needed to identify these effects.

Anticipated impacts of wind development specifically include: collisions with turbine blades, fences, guy wires, power lines, and vehicles; behavioral avoidance and habitat fragmentation; auditory and visual disturbance; increased predator access; poaching; spread of invasive weeds; and increased fire frequency (Leddy et al. 1999, USFWS 2003, Connelly et al. 2004, Manville 2004, Sharp 2005, Schroeder et al. 2006). Impacts from power lines include: behavioral avoidance, habitat fragmentation, collisions, and increased predator access (Aldridge 1998, Braun 1998, Connelly et al. 2000, Boisvert 2002, Braun et al. 2002, Hagen 2003, Wolfe et al. 2003a, 2003b, Pitman 2003, Connelly et al. 2004, Hagen et al. 2004, Patten et al. 2005 and Hoffman and Thomas 2007). Lacking specific research, it is prudent to expect that industrial-scale wind development will have impacts on both sage-grouse and sharp-tailed grouse primarily due to habitat alterations and behavioral avoidance. However, direct mortalities from collisions are not expected to be a problem if turbines are sited outside major movement corridors.

Collisions between fowl-like birds and turbines are less common than collisions involving other species, especially passerines and bats. Summarizing the results of 5 studies in the U.S. outside California, Erickson et al. (2001:37) reported 4.0% of birds killed in collisions with wind turbines were fowl-like species. Three of the studies reported no mortality of fowl-like species, one reported 5.5% of the birds killed were fowl-like species and an Oregon facility reported 25% of the birds killed were fowl-like species. Strickland (2008) found that, relative to their abundance, game birds comprised 11% of the fatalities analyzed nationwide. Braun (cited in Manville 2004) believed sage-grouse could avoid collisions with turbines due the large size and visibility of these structures. Most prairie grouse typically fly below the sweep of turbine blades. However, WGFD biologists have observed sage-grouse flying at fairly high elevations above ground when moving long distances. The potential for grouse to collide with turbine blades should not be discounted if turbine strings and power lines are located within migratory pathways between habitats used on a daily or seasonal basis. In addition, collisions with barbed wire fences are fairly common and potential for collisions with guy wires and power lines is recognized by several authors (Connelly and Braun 1997, Becker et al. 1999, Schroeder et al. 1999, Connelly et al. 2004, Manville 2004, Connelly 2005, Braun 2006, Stemler 2007).

Several studies have also documented a “shadow flicker” effect resulting from the projection of moving turbine shadows onto the ground, roads, or buildings (Nielsen 2003, DWEA 2003, Hotker et al. 2006:24, National Research Council 2007, Hewson 2008). There is speculation that this “flicker” effect may resemble avian predators and disturb grouse and other small prey species that are sensitive to avian predation from overhead. Specific research examining this issue is needed.

Impacts to sage-grouse and sharp-tailed grouse from wind development have not been specifically studied, but information from other energy studies lend some insight. For prairie grouse, there is a considerable body of literature describing impacts of roads, power lines, and natural gas wells. Roads with light traffic (1-12 vehicles/day) were correlated with less successful nesting by sage-grouse hens (Lyon 2000). Light traffic near leks may also reduce nest-initiation rates and increase distances hens move from leks during nest-site selection (Lyon and Anderson 2003). In addition, Braun (1998) determined habitat use by sage-grouse was impacted by power lines up to a distance of at least 600 m. Other studies have indicated little or no impact from power lines. In Montana habitat selection was modeled for three sage-grouse populations in Beaverhead County based on a radio telemetry study involving 45 male sage-grouse during the summers of 2001 to 2005. One of the parameters used in the model was distance to the nearest power line. However, the distance to power line variable was not found to be associated with sage-grouse habitat selection, suggesting that presence of transmission lines did not affect habitat selection by the male sage-grouse monitored during this study (Wisinski 2007).

Recent studies have determined that sage-grouse leks are impacted by nominal levels of natural gas development equating to 1 well pad/mi^2 within 2 miles, and are highly impacted when development exceeds 2-3 well pads/mi^2 (Naugle et al. 2006, Walker et al. 2007, Doherty 2008, Walker 2008, Doherty et al. 2008, Naugle et al. *in press*). Wind developments typically contain much higher densities of tall structures that are associated with motion and shadow flicker.

Concerns exist that wind development will cause significant adverse impacts to sage-grouse and sharp-tailed grouse if they are sited in habitats that are important to those species. After a wind farm was build in alpine habitat, in Austria, five years of monitoring data on black grouse (*lyrurus tetrix)* populations showed a decrease in their population (Zeiler, Hubert P, Granschachner-Berger, Veronika. 2009). Naugle et al. (*in press*) has described the mechanism of this impact: “Recent research shows that sage-grouse populations decline when cumulative impacts of development negatively affect reproduction or survival (Aldridge and Boyce 2007), when birds behaviorally avoid infrastructure in one or more seasons (Doherty el al. 2008), or both (Lyon and Anderson 2003; Holloran 2005; Kaiser 2006). Behavioral avoidance of energy development reduces the distribution of sage-grouse and may result in population declines if density-dependence or habitat suitability lowers survival or reproduction in displaced birds (Holloran and Anderson 2005; Aldridge and Boyce 2007). Adult female sage-grouse in Canada led their young into the Manyberries Oil Field where succulent forbs were abundant, but despite this attraction, the oil field was a population sink where risk of chick mortality increased 1.5 times for each additional well visible within 1 km of the brood (Aldridge and Boyce 2007). In the Powder River Basin, sage-grouse were 1.3 times less likely to use otherwise suitable winter habitats that have been developed for coal bed methane (12 wells/4 km^2), and differences were most pronounced in high quality winter habitat with abundant sagebrush cover (Doherty et al. 2008). However, current research (G. Johnson, Pers. comm.) has documented the current use of sage grouse leks within one mile of an established wind project after 2 years of construction. Continued long-term persistence of these leks still needs to be evaluated to account for lag affects (Holloran 2005).

Plains sharp-tailed grouse may be somewhat more adaptable to changes in their environment than are sage-grouse. Nebraska Game & Parks Commission staff has been monitoring greater prairie chicken and sharp-tailed grouse leks near the Ainsworth Wind Energy Facility. All 13 leks have been active each of the three years since construction, and the number of birds on the leks has remained stable. These leks are 0.3-1.59 miles from the nearest turbine (avg. = 0.66 miles) (Nebr. GPC, Pers. comm.). Baydack and Hein (1987) found that male sharp-tailed grouse continued to display on leks when confronted with several types of experimental disturbance treatments. However, female sharp-tailed grouse were not observed on any lek during disturbance treatments. Sensitivity of females may limit reproductive success at lek sites exposed to disturbance. Others have documented this disturbance mechanism among female sage-grouse in an area of natural gas development (Lyon 2000, Lyon and Anderson 2003). In addition, yearling male sage-grouse were recruited onto disturbed leks at a lower rate than on undisturbed leks (Braun 1986; Kaiser 2006; Walker 2008), resulting in a time lag between the onset of disturbance and the ability to detect an impact (Walker 2008).

Several researchers and managers have recommended set-back distances to protect leks and other important habitats from disturbances caused by development. Set-back distances are intended to buffer the disturbance reaching the lek and surrounding habitat in order to maintain effective habitat conditions. The distances vary depending on whether the goal is to simply minimize disturbance to the lek itself, or to also protect nesting and brood-rearing habitats that are associated with the lek. These recommendations and research findings provide additional insights regarding the distances at which wind development is expected to adversely affect prairie grouse.

MIGRATORY WATERFOWL, WATERBIRDS, AND SHOREBIRDS

Wind developments may impact migratory game birds and waterbirds depending on site location and species that are present. As with other bird species, three types of impacts are anticipated: 1) direct mortality due to collisions with turbines, power lines, and meteorological towers; 2) displacement of migratory birds from preferred feeding, resting, or nesting areas; and 3) alteration of migratory pathways.

Waterfowl typically fly at heights and distances that put them at risk for collisions (Mabey and Paul 2007). Erickson et al. (2001) reported 78% of the carcasses found in 31 studies of wind projects were passerine species. However, wetland-associated species comprised the second largest category of collision mortalities and included waterfowl (5.3%), waterbirds (3.3%), and shorebirds (0.7%). Projects with sources of open water near turbines (e.g., San Gorgonio, California, and Buffalo Ridge, Minnesota) have the highest documented waterfowl mortality, with 10 to 20% of all fatalities consisting of waterfowl and shorebirds (BLM 2005:5-63). In addition, collisions with power lines are an important source of mortality for several species of waterbirds (Fiedler and Wissher 1980, Crivelli et al.1988, Morkill and Anderson 1991, Pacific Flyway Study Committee 2002, Manville 2005, Rubolini et al. 2005).

Weather can increase the incidence of collisions with tall structures, in particular with regard to nocturnal migrants (Mabey and Paul 2007:103). For example, most Trumpeter Swan (*Cygnus buccinator*) collisions with power lines and fence wires occurred during winter fogs (Banko 1960). Presence of fog at wetlands with high waterfowl densities contributes to waterfowl mortality associated with power lines (Andersen-Harild and Block 1972). The same concern would likely apply to wind turbines if they are sited near wetlands.

The potential for avian collisions was a major issue prior to construction of the Forward Energy Wind Project near the Horicon National Wildlife Refuge in Wisconsin (USFWS 2004). Ultimately, the project sponsor was required to set all wind turbines back at least 2 miles from the refuge property boundary (Public Service Commission of Wisconsin 2005:19).

Displacement of waterfowl from wind development has been investigated in coastal regions of Europe where this is considered to have a greater impact on birds than collision mortality (Strickland 2004). Studies suggest most displacement involves migrating, resting and foraging birds. Displacement distances range from 75 to 800 m away from turbines (Strickland 2004). Sea ducks including long-tailed duck (*Clangula hyemalis*), common eider (*Somateria mollissima*), and common scoter (*Clangula hyemalis*) are particularly vulnerable to turbine impacts (Gill *et al.* 1996; Langston and Pullan 2003; Garthe and Hüppop 2004; Stewart et al. 2007:6). Krijgsveld (2007) also reported pochards (*Aythya ferina*), mergansers (*mergus spp.*) and goldeneyes (*Bucephala clangula*) were disturbed by an operating wind project in the Netherlands, although several other species did not appear to be affected.

Waterbirds and waterfowl may avoid feeding in areas near wind turbines (IDNR 2007, Kingsley and Whittam 2003); however, in areas near wetlands or other areas of waterfowl concentration, these birds are at more risk of collision when entering and departing the area (IDNR 2007). Although shorebirds have a lower risk of collisions with turbines due to the height at which they migrate, wind turbines located near shorebird feeding and staging area can be detrimental during takeoff and landing, particularly if birds are disturbed and forced to flee (Kingsley and Whittam 2003). Turbine design, including height, blade length, rotor tip speed, blade appearance to birds, and the presence and type of lighting, also plays a role in collision risk (Kuvlesky et al. 2007).

In addition to displacement, wind turbines can have a barrier effect, causing waterfowl, wading birds, and shorebirds to alter migration paths considerable distances (Noer et al. 2000, Percival 2001, Bruns et al. 2002, Christensen et al. 2002, Langstron and Pullan 2002). Krijgsveld (2007) made the following observation in the Netherlands: “Water birds were found to avoid the wind energy development on a large scale when the turbines were moving. During turbine operation, the number of flight movements *outside* the wind farm was much greater (85% during the day, 75% during the night) than flights *through* the wind farm. Waterbirds made long deflective flights to avoid the wind farm when the turbines were moving … When turbines were not moving, birds cut through the wind farm."

Although these studies were done predominantly within coastal regions, it is reasonable to anticipate similar effects on waterfowl and other wetland-associated species if turbines are sited within or near freshwater marshes, streams, and lakes.

BIG GAME

The effects of wind energy development on large ungulates are largely unknown. There has been little research completed on the subject to date, although ongoing monitoring and research in Wyoming is expected to begin to provide information within the next few years.

Direct ungulate habitat loss from wind energy development surface disturbance may be relatively small as turbines and roads typically constitute only a small percentage of the development area. However, indirect habitat impacts, those affecting use of undisturbed and adjacent portions of the project area by ungulates may be much larger. For instance, habitat security, an important factor in determining use of habitats by many big game species, may be compromised.

Estimates from the Foote Creek Rim Project in Wyoming suggest that long-term surface disturbance was 0.7-1.0 acres per turbine, or 0.4-0.7 acres per MW (Strickland 2004). Although actual disturbance associated with wind turbines and their associated roads and other infrastructure is relatively small, indirect impacts may affect much larger areas. Consequently, the potential exists to displace big game species from important seasonal habitats particularly crucial winter ranges. In addition, if displacement does occur additional impacts could include a loss of connectivity between necessary seasonal habitats including migration routes, parturition areas and important summer ranges all of which provide essential habitat components to maintain big game populations across Wyoming. The lack of connectivity may fragment habitats, resulting in a decrease in the quality and attractiveness of remaining patches of habitat in areas adjacent to infrastructure (Berger et al. 2006).

Wyoming is home to the largest number of pronghorn antelope in the U.S. (and the world as they are a distinct North American species). Current estimates are at 526,000 (WGFD 2009 Annual Report). Pronghorn primarily inhabit open landscapes comprised of sagebrush steppe or grassland habitat types. These areas often coincide with economically attractive wind. Mule deer also use these landscapes for year round habitat or as seasonal winter ranges. Potential impacts to pronghorn and mule deer include direct and indirect habitat loss, displacement, and cumulative impacts associated with other nearby energy development.

Pronghorn and mule deer have been observed to maintain populations in developed areas such as surface coal mines (Segerstrom 1982, Medcraft and Clark 1986, Gamo and Anderson 2002). Others (Sawyer et al. 2006) have found mule deer remain, but at reduced populations, in response to natural gas development. Sawyer et al. (2006) and Berger et al. (2006) found that mule deer and pronghorn exhibited avoidance behavior of gas development areas or selected habitats away from development. Wind projects also have road networks, other infrastructure and human activity; however, the impact may be different as wind projects generally require fewer roads, less operational traffic, and different types (and sizes) of permanent structures.

It is difficult to predict the impact of wind development in Wyoming to big game species. There is a need for research, as has occurred with oil and gas development, to identify and assess the impacts of wind development and determine appropriate mitigation for these species.

To date there has been one single study performed on the direct effect of wind development on elk (Walter et. al. 2006). This study found that elk were displaced from wind development activities during construction but after construction was completed less displacement was noted. However, caution is warranted in applying the results of this study to large free-roaming elk herds found in Wyoming as Walter's study was performed on a non-migratory herd of elk in southwestern Oklahoma. This herd was adjacent to a very large high-fenced wildlife refuge. The fence limited their movement to those habitats behind the fence, which were away from the wind development activities. This herd also inhabited an area of many small tract-private agricultural lands that are intersected by road systems and residential developments. These elk were likely more habituated to human presence than Wyoming elk would be and likely do not accurately represent the majority of Wyoming's elk herds.

In other published literature (Perry and Overly 1977, Rost and Bailey 1979, Lyon 1983) elk have been demonstrated to be highly sensitive to disturbance from vehicle traffic and will actively avoid roads. Many of these studies evaluated elk response to logging or other forest use activities. The network of roads that is constructed for wind projects in elk habitat could displace elk depending upon the amount of human activity. Increased human activity, often associated with roads, can displace elk, resulting in increased movements and associated energetic costs (Rumble et al. 2006).

Another big game species potentially affected by wind development in Wyoming is bighorn sheep. Some lands near bighorn sheep populations have been leased for wind development in the Laramie Range. Bighorns often inhabit relatively treeless ridges or mountainsides (Gionfriddo and Krausman 1986). During winter bighorns can be found on windswept ridges foraging in areas with less snow (Tilton and Willard 1982). As with elk, bighorns are sensitive to human activity and have more strict requirements in habitat needs (Smith et al. 1991). There is currently a lack of information specific to the potential effects of wind development on bighorn sheep but it is WGFD's experience that they are one of the more disturbance-sensitive big game species.

SMALL MAMMALS

Impacts to small mammals from wind development are largely unknown and will likely vary depending on site location and species present. Several types of impacts could potentially occur, however others not yet identified are also possible: 1) mortality due to ground-disturbing activities; 2) displacement of small mammals from preferred feeding areas; 3) disturbance due to "shadow flicker"; 4) disturbance due to noise; 5) loss of burrows and escape cover; and 6) injury and mortality due to vehicle collisions.

Information describing impacts of wind development to small mammals is lacking. Both individuals and populations could be impacted both positively and negatively. Except in the case of rare species (such as the Wyoming pocket gopher, Preble's meadow jumping mouse, etc.), impacts to small mammals are often perceived as minimal and of lower priority when compared to other more conspicuous species, such as avian or volant mammals. Although small mammals are unlikely to collide with turbines, they are vulnerable to surface disturbing activities and colliding with vehicles. The construction of turbines and associated infrastructure is likely to have localized impacts on populations and individuals and the impacts will vary depending on the species life history (e.g., semi-fossorial, body size, diet, etc), abundance, and habitat requirements. Additional data is needed.

AMPHIBIANS AND REPTILES

In general, information regarding the affects of wind energy development on Wyoming's herpetofauna is lacking. It has been shown that reptile and amphibian species are affected by energy development differently based upon unique characteristics of its life history (Hampton et al. 2010, Smolensky 2008). However, there is no clear trend on generalized impacts. Permanent bodies of water, wetlands, ephemeral pools, and playas are of particular concern because amphibians are highly dependent on water to complete their lifecycle (aquatic tadpole or larval phase). Any natural or human-caused loss of water on the landscape during the larval period could negatively affect amphibian populations. This effect could be exacerbated with successive years of water loss. While we understand that wind turbines would not typically be constructed in areas important to amphibian life cycles, we remain concerned that without adequate pre-construction surveys, roads, buried power lines and other ancillary facilities could be constructed in habitats important to amphibians and that localized, long-term population impacts may occur. We are also concerned that off-site transport of sediment from construction sites may adversely affect the quality of habitats important to amphibians.

Amphibian road mortality may increase during specific times of year based upon species-specific breeding chronology. Spring breeding migrations and summer post-metamorphic emergence, result in amphibian congregations which could result in locally significant mortality events if these congregations were located on or near roads or other ground-disturbing activities. It is particularly important that data be collected for amphibians and habitats, particularly for those species which are considered Species of Greatest Conservation Need (SGCN) in the State Wildlife Action Plan, to ensure that impacts are minimized.

As with amphibians, specific information regarding the effects of wind energy development on reptiles is also lacking. While development could increase basking opportunities for many reptiles, adverse effects could occur to daily routines from human presence, surface disturbance, traffic, and noise. Many reptile species are dependent on rocky outcroppings or accessible geologic features for hibernation, and thus, it is suggested that these features be avoided to ensure the integrity of hibernacula (overwintering areas or dens).

MANAGEMENT CONCERNS

In addition to concerns about wind development on the impacts of wildlife and habitat are issues associated with the management of game species within development areas. Population management requires the use of hunting as a tool for managing species at population levels acceptable for sportsmen and sportswomen as well as trying to meet the needs of private landowners whose lands contribute to available habitat for wildlife. Development of wind energy on public land creates potential access, and public use concerns while development on private land has the potential for restricting public access open in the past, particularly for hunting. Maintaining hunter access to formerly available lands that are developed for wind energy is vital to enable WGFD to successfully manage game populations and the habitats upon which they depend, to maintain the quality of the hunting experience in Wyoming, and to reduce subsequent overcrowding of remaining public areas used by hunters.

Access to public land in Wyoming will not immediately be affected by the development of wind. To close access to public land Federal land management agencies would be required to institute an official closure, which would consist of issuing a public notice with a comment period. This includes access for hunting. However, access on private land would be dependent upon the lease agreement between the wind developer and the private landowner. The WGFD recognizes the rights of private landowners and will respect the decisions they make regarding access to their lands. However, no-hunting stipulations due to the presence of wind development on lands whose owners typically provided access, would severely impact the ability of WGFD to control wildlife populations. In addition, WGFD is committed to working with private landowners, wind developers, local law enforcement and land management agencies to help minimize and report damage to wind turbines or meteorlogical towers caused by vandals with firearms.

AQUATIC CONCERNS

A common assumption is that aquatic wildlife impacts are unlikely to be associated with wind projects. In many cases, that assumption would be correct. For example, wind turbines are often placed on the highest possible topographic features in a project area to access stronger and steadier winds found at higher elevations. As a result, turbines are rarely located in low spots where permanent or ephemeral riparian habitats usually occur. Furthermore, the aridity of Wyoming's climate, combined with the rarity of riparian habitats, creates a reduced potential for impacts to aquatic habitats relative to other regions with more precipitation.

Currently, there is a relatively small body of research on the effects of wind development on aquatic habitats. This can be partially explained by the relatively few potential wind/aquatic conflicts that have been identified at wind projects in the past and the recent nature of wind development proposals. However, there is much information on the impacts of roads and pads and culverts, associated with various forms of development, on how water runs off the landscape and how sediment is mobilized and delivered to watercourses. The combination of runoff changes and sediment delivery changes, associated with any project, has the potential to modify the aquatic habitat characteristics of stream channels.

Aquatic habitat changes may occur if roads and pads affect the infiltration rate of water, by increasing the velocity and quantity of water running across the landscape, and potentially increasing erosion and sediment deposition into nearby waterways. When erosion occurs, stream channels respond to the increased sediment supply by adjusting their pattern (sinuosity) and dimensions. These changes may result in decreased pool depths, decreased riffle area, less diversity in channel substrate and increased lateral instability marked by eroding banks. These changes along with direct effects from increased sediment loading can affect macro invertebrate populations and diversity and decrease fish habitat. A common impact is a decrease in gravel and cobble used by spawning fish.

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<u>APPENDIX A</u>
WIND ENERGY DEVELOPMENT
BEST MANAGEMENT PRACTICES

These recommended Best Management Practices apply only to the activities of wind developers and their contractors and subcontractors.

1. Our recommendations (including the best management practices and monitoring recommendations) may not be applicable to all wind projects in the state and are intended to be applied based on specific characteristics of a project site determined during pre-construction surveys and in consultation with WGFD. Early consultation with WGFD is the best means available for developers to determine which recommendations are appropriate for their project area. These recommendations apply only to that portion of collector lines located within a wind generation project area boundary. Recommendations for collector lines outside of a wind generation project area boundary and for transmission lines will be developed on a case-by-case basis.

2. We recommend project developers engage early with the USFWS to obtain their input on siting, monitoring and potential impacts to wildlife and habitat.

3. Project developers should consult with the WGFD at least two years prior to submitting permit applications so that appropriate studies can be conducted and site-specific recommendations can be developed.

4. Wind development is not recommended in sage grouse core areas.

5. Developers should use the statewide wind energy/wildlife conflict map (GIS shapefiles available at http://gf.state.wy.us/habitat/ TerrestrialHome/ WindDevelopment/index.asp) as one of the first steps in evaluating the suitability of leases and pre-development planning.

6. To the extent practicable, site wind turbines and ancillary project components within habitats/areas already affected by other forms of development (e.g., cropland, oil and gas fields, mine sites).

7. Developments proposed within 2 miles of WGFD wildlife habitat management areas should be coordinated with WGFD to avoid or minimize impacts to associated wildlife species and habitats.

8. Developments proposed within 2 miles of federal wildlife refuges should be coordinated with WGFD and USFWS to avoid or minimize impacts to associated wildlife species and habitats

9. Avoid placing turbines in documented locations of any species of wildlife, fish, or plants protected under the Federal Endangered Species Act.

10. Within 2 miles of the perimeter of an occupied non-core SAGE GROUSE lek, construction activities should not occur between March 15 and May 15. The WGFD recommends that developers monitor leks subject to this recommendation to evaluate its effectiveness in reducing the impacts of wind development on sage-grouse.

11. A habitat map delineating vegetation types should be developed for each project.

12. Any construction/development activities within 2 miles of the perimeter of occupied Plains and Columbian sharp-tailed grouse leks should be suspended from April 1 – July 15.

13. Turbines and all related above ground infrastructure, including roads, should occur outside a 0.25 mile (no surface occupancy) distance from the perimeter of sage-grouse leks in non-core habitat.

14. Turbines and all related above ground infrastructure, including roads, should occur outside a 0.25 mile (no surface occupancy) distance from the perimeter of plains sharp-tailed grouse leks.

15. Turbines and all related above ground infrastructure, including roads, should occur outside a 0.6 mile (no surface occupancy) distance from the perimeter of Columbian sharp-tailed grouse leks.

16. Avoid siting wind energy facilities within crucial big game ranges including crucial winter, identified parturition, and migration corridors.

17. If siting within big game winter ranges cannot be avoided, suspend construction activities from November 15-April 30.

18. If siting within identified big game parturition areas cannot be avoided, suspend construction activities from May 1-June 15.

19. Avoid placing wind energy facilities in locations that bisect major big game migration corridors as determined by on the ground mapping.

20. To the extent practicable, roads and fences should not bisect or run immediately adjacent to any natural water feature potentially preventing wildlife from reaching adjacent habitat.

21. To the extent practicable, herptile habitats for SGCN species, such as fallen trees, prairie dog colonies, and potential basking rocks, should be left intact.

22. Avoid siting wind energy facilities within 0.25 mile of identified habitat used by SGCN amphibians and reptiles.

23. Developers and their contractors should be instructed to follow posted speed limits to reduce, to the extent possible, collisions with all wildlife.

24. Where feasible, place power lines collecting electricity from turbines underground. Use recommendations of the APLIC (1994, 2006) for any required above-ground lines, transformers, or conductors.

25. Within wind generation project area boundaries avoid overhead power ~~or collector~~ line crossings of naturally occurring perennial streams, lakes, reservoirs, riparian corridors, and large (>5 acres) wetlands, where feasible.

26. When siting wind turbines within 2 miles of naturally occurring wetlands, riparian areas, lakes, reservoirs, and forested habitats collect adequate information to demonstrate that specific turbine locations will not result in significant levels of impacts to associated wildlife species and habitats. Determinations should be made on a project specific basis based upon site-specific data and information.

27. Use non-guyed non-lattice meteorological towers or attach bird diverters to guy wires on guyed met towers.[1]

28. In coordination with WGFD and USFWS, determine appropriate set-backs from ridges, bluffs or other features to avoid or minimize impacts to bats, neotropical birds, migratory birds or raptors. Determinations should be made on a project specific basis based upon site-specific data and information.

29. Minimize construction of all roads, fences and other ancillary facilities to reduce overall fragmentation; use bird diverters on fences with high potential for strikes within **0.6** miles of sage-grouse leks in core areas; 0.25 miles of sage-grouse leks in non-core areas and use or upgrade existing roads rather than constructing new roads where possible~~,~~ .

30. If sage-grouse mortality due to collisions with fences is documented implement appropriate actions to mitigate impacts.

31. Close access and maintenance roads to public travel except preexisting roads on public lands (as applicable to management purposes).

32. Access for hunting should continue within wind leases on public lands and on private land with landowner permission. Wind developers should not require indemnification from landowners who are willing to provide public access for hunting and fishing or from sportsmen and sportswomen who utilize the property.

[1] Wyoming State Law requires all new and existing wind energy met towers to be mapped within the Wyoming Department of Transportation information system and marked to be visible from 2000 feet during daylights hours. This information is available to the aviation community on the Wyoming Department of Transportation website --http://gf.state.wy.us/METTowers/default.aspx.[1]

33. Adopt appropriate turbine design and siting standards to minimize bird and bat collisions (see U.S. Fish and Wildlife Service 2003: and DOI Wind Turbine Guideline Advisory Committee Recommendations 2010).

34. While still providing for site-security and workplace safety, applicants should comply with the DOI Wind Turbine Guideline Advisory Committee Recommendations (2010) regarding lighting where possible.

35. Developers should consult with existing landowners, WGFD, and the authorized land management agency to determine the location of new fences and what types of fence design and construction are appropriate based on the wildlife resource and needs of the existing landowner and/or land management agency.

36. At the completion of each project construction phase provide WGFD as-built maps of roads, turbine locations and ancillary project components in a GIS format.

37. Construction should be suspended within buffers and during the dates specified around raptor nests as provided in Appendix B and as updated by USFWS and WGFC.

38. Map and control noxious and invasive weeds within project area.

39. Developers are responsible (physically and financially) for monitoring and disposing of carcasses and handling/rehabilitation of injured wildlife on the project area. Developers are required to obtain the appropriate WGFD Chapter 10 and 33 permits and any USFWS requirements.

APPENDIX B
COORDINATION/CONSULTATION WITH PRIVATE LANDOWNERS & WIND DEVELOPERS, SITE SELECTION, BASELINE DATA COLLECTION & MONITORING RECOMMENDATIONS FOR WIND DEVELOPMENT, RECLAMATION, AND MITIGATION PRACTICES

COORDINATION/CONSULTATION WITH PRIVATE LANDOWNERS

Affected private landowners are an integral part of WGFD/Wind Developer consultations. "Affected landowners" are defined as any person, or their designated representative, holding record title to land on which any portion of a commercial facility generating electricity from wind is proposed to be constructed. The coordination/consultation process outlined below will include all wind generation facilities located on private lands including that portion of any collector system located on those same lands.

Prior to entering into any agreement with a wind energy developer to undertake studies or monitoring activities on private lands that precede efforts to develop a Conservation Plan, the WGFD shall request from the developer a written statement certifying that all affected landowners have been notified of the proposed studies or monitoring activities and have granted all necessary access for the purpose of such studies or monitoring.

Prior to entering into any substantive discussions with the WGFD regarding WGFD recommendations for wind energy development, but in no case less than six months prior to the submission of an application for development:

- WGFD shall request from the developer contact information for all affected landowners. WGFD will not meet with developers until a list of affected landowners has been provided by the developer.
- The WGFD shall notify affected landowners of all meetings between WGFD and the developer.
- Affected landowners or their representative shall be entitled to participate in all discussions between the developer and the WGFD.

Prior to submittal of any recommendations from the WGFD to the ISC and/or to local governments, the WGFD shall collaborate with the affected landowner(s) and the developer to develop a "Conservation Plan" for affected private lands incorporating mutually agreed upon goals and practices. In development of this Conservation Plan:

- Discussions shall be conducted in a collaborative manner.

- The parties may mutually agree to utilize a facilitator or to engage in mediation with such facilitator or mediator approved by all parties.
- The WGFD will designate a WGFD representative to the discussions who is mutually acceptable to the affected landowners and the WGFD.
- If the landowner and the developer have agreed to certain conservation measures prior to initiation of the collaboration required under this section, the WGFD shall accept these as components of the Conservation Plan or provide in writing the reasons for their rejection.
- The final Conservation Plan shall be signed by the developer, the affected landowners or their authorized representative and the Director of the WGFD.
- The Conservation Plan shall be incorporated into developer's Permit Application to ISC.
- The Conservation Plan shall become the WGFD "recommendations " under W. S. 35-12-110 (b) and (c) and the WGFD recommendations to any local government entity.
- The parties shall jointly advocate for ISC incorporation of the Conservation Plan into the developer's permit.
- A Conservation Plan shall not be binding on any party unless it has been signed by a majority of affected landowners or by landowners representing a majority of the affected private lands. A Conservation Plan shall be binding only on parties signatory to that Plan.

If any affected landowner or the project developer declines to participate in the Conservation Plan process or a Conservation Plan is not successfully developed and signed by the WGFD, an affected landowner or the project developer :

- WGFD shall provide contact information provided by the developer for all affected landowners to the ISC.
- The landowner, with or without the concurrence of the developer, may submit a conservation plan to the ISC.
- The WGFD may make recommendations to ISC as provided by statute as to lands not under a joint Conservation Plan.
- The process will proceed as outlined in the Industrial Development and Siting Act.

SITE SELECTION

Appropriate site selection for wind energy development is key in preventing negative impacts to wildlife. Therefore, detailed planning and survey efforts prior to investment and eventual construction will help identify and avoid problems that may occur, determine sites that are unsuitable for development, and minimize or mitigate impacts that cannot be avoided. In general, previously altered landscapes, such as cultivated, industrial, and urbanized areas with existing roads and power line corridors are, from a wildlife perspective, more fitting locations for wind development.

Our wind energy development recommendations are aimed at abiding by the following guiding principles.

1. Establish regulatory clarity and consistency while still providing adequate protection of Wyoming's wildlife resources.

2. Attain methodological consistency in the development of pre and post- construction monitoring requirements.

3. Develop monitoring protocols that are scientifically sound while establishing reasonable certainty about the direct and indirect effects of wind development on wildlife.

4. Maintain a degree of reasonable flexibility to accommodate the unique characteristics of each proposed wind development.

5. Facilitate effective communication between project proponents and WGFD while also complimenting other local, state, and federal wildlife-related regulatory processes without creating conflicting recommendations.

6. Acknowledge the consequences that would result from the addition of Greater Sage-grouse or any other species to the federal list of threatened or endangered species.

7. Establish a process to determine appropriate mitigation in the event that unforeseen wildlife conflicts arise during or after the construction of a wind energy development.

The following recommendations for baseline data collection and monitoring have been developed by WGFD staff to lessen future impacts to wildlife and facilitate planning for wind development. In all cases, baseline and monitoring data and reports will be provided to WGFD (Habitat Protection Office and appropriate Regional Office) on an annual basis. In addition, all research and monitoring design and results must be made available for review by the WGFD and in some instances may require independent peer review.

Consistent with the FAC Draft Guidelines (2010), WGFD offers a tiered approach to our review of wind development. We recommend that industry meet with WGFD very early in the process (pre-site selection, pre-planning) to best identify potential issues. We advise that initial discussion with WGFD begin at least 2 years prior to the submittal of any applications.

Tier 1- Site Selection

The objective of Tier 1 is to help the developer identify site(s) to consider or reject for wind development based on potential or known conflicts with wildlife resources. Questions to address under this tier include:

1. Are there species or habitat(s) of concern present on the site?

2. Does the landscape contain areas where development is precluded by law, regulation or policy?
3. Are there known crucial areas for wildlife such as hibernacula, winter ranges, migration corridors, or other vital/sensitive habitats?
4. Are there large areas of intact habitat with species where habitat impacts are a concern?
5. Using best available scientific information, has the potential presence of important species or crucial/vital habitat been documented?
6. Which SGCN or interest is likely to use the proposed site based upon known data?

Tier 2- Field Monitoring to Document Wildlife Conditions and Potentially Predict Project Impacts

The objective of Tier 2 is to identify site-specific conditions regarding wildlife species and habitats based on pre-construction monitoring. Questions include:

1. Does pre-construction monitoring indicate that SGCN are present on or likely to use the proposed site?
2. Does monitoring indicate the potential for adverse impacts on the wildlife species or habitat?
3. If adverse impacts are predicted to a species or habitat, can these impacts be avoided (preferable) or mitigated?
4. Is monitoring needed for construction and post-construction?

Tier 3- During and Post-Construction Monitoring

This Tier identifies impacts to species and habitats and can provide the basis for designing and implementing appropriate mitigation. Questions include:

1. What is the bird and bat fatality rate for the project?
2. Have sage-grouse lek counts changed?
3. Has raptor nesting and production been affected?
4. Has big game distribution on crucial ranges changed, and, if so, how and to what degree?
5. Has big game population parameters (recruitment rates, etc.) changed?
6. Has other species of interest distribution and habitats been altered?

BASELINE DATA COLLECTION AND MONITORING RECOMMENDATIONS

Bats

The following are general recommendations aimed at standardizing surveys to improve our understanding and provide guidance on collection of baseline data related to bat issues (e.g., causal factors, species susceptibility, distribution, abundance, and behavior). These recommendations were developed by WGFD and the Wyoming Bat Working Group (WYBWG) specifically to address survey standardization in Wyoming. If additional information on broader objectives is required please consult survey recommendations in Hester and Grenier (2005). These recommendations are intended to provide specific details (e.g., timing, duration, equipment, etc.), yet remain flexible enough to provide managers with the ability to prescribe appropriate surveys (e.g., pre- and post-construction, etc.) across a broad range of project sites. A combination of multiple approaches (e.g., passive and active acoustic or passive acoustic and carcass searches, etc.) is recommended and survey strategies may vary by site. Please refer to the Survey Matrix (Table 1) for additional guidance. As bat survey methods advance the WGFD and WYBWG will evaluate new techniques and equipment for potential application in the state and revise these recommendations if new methods are appropriate.

In general, we recommend surveys be conducted for a minimum of 2 years prior to construction and 3 years post construction to be consistent with recommendations for other wildlife species (i.e., birds, sage-grouse and big game).

Habitat Evaluation

1. Objective – Identify and quantify existing bat habitats within a project site.

2. Rationale – The results can be used to identify potential roosting and foraging areas for bats within project sites to prioritize surveys and improve siting. The analysis can also be used to quantify changes in habitat.

3. Equipment – No specialized equipment is required, however, analysis is most easily completed using remote sensing techniques (e.g., aerial or satellite imagery) and GIS.

4. Application – A pre-construction evaluation should be completed by identifying potential foraging areas (i.e., Forest and Woodlands, Grasslands and Shrub-steppe, Riparian Corridors, and Water Features) and roosting areas (i.e., Rock Shelters, Forest and Woodlands, Riparian Corridors) within the project boundary. Please refer to "A Conservation Plan for Bats in Wyoming" (Hester and Grenier 2005) for additional information on habitats and associated bat species. Habitat can be evaluated either remotely (e.g., GIS) or using ground surveys. Delineate foraging and roosting habitats within the project site. If the pre-construction evaluation is done using remote sensing then field verification is also recommended. Compare proposed turbine siting data with the results of the habitat evaluation to identify potential conflict areas.

   A post-construction habitat evaluation is recommended following development of the project site. Compare pre- and post-construction habitat evaluations to quantify changes in habitats within the project site.

5. Analysis of Data – Total area and the percentage of each foraging and roosting habitat type present within the project area prior to construction should be reported.

Passive Acoustic Surveys

1. Objective – Identify and quantify bat species and relative abundance near the rotor sweep zone.

2. Rationale – Results can be used to identify bat species presence and describe bat behavior (e.g., spatial and temporal use, etc.) likely to occur near rotor sweep zone. Data can also be used as an index of relative abundance for this component of the project area. For passive acoustic survey recommendations that address broader objectives see Hester and Grenier (2005).

3. Equipment – There are many systems available for acoustic monitoring of bats (e.g., AnaBat, Pettersson D500x, Binary Acoustics, etc.). The AnaBat system is the only known acoustic monitoring system currently being used in Wyoming. If other systems are to be used please consult the WYBWG prior to data collection to ensure that survey equipment is compatible with survey objectives.

4. Application – Passive acoustic survey stations should be designed to collect bat calls at ≥ 50 m whenever possible to identify activity within the rotor sweep zone. Met Towers often provide an appropriate structure for this type of data collection. At least one acoustic unit, aimed away from the prevailing wind direction, per Met Tower should be utilized. A second unit, placed near the ground (e.g., < 5 m), can be used to quantify bat activity below the rotor sweep zone in areas that concentrate bat use (e.g., roosting or foraging areas, etc.).

   Units should be deployed between April 15 and October 15 and be programmed to begin data collection ½ hr prior to sunset and end data collection ½ hr after sunrise. Equipment should be calibrated annually and checked bi-monthly to ensure that units are properly functioning. Non-functioning equipment should be replaced immediately. Storage cards should be rotated bi-monthly for data analysis.

   The number of acoustic survey stations needed for a project will vary depending on the available bat habitat in the area. If few (e.g., ≤ 2) survey stations are used during the pre-construction survey period, then the data collection period may need to extend past two years to ensure that the data accurately reflect conditions (e.g., species diversity, temporal and spatial use, etc.) within the project area.

   Results from previous studies have demonstrated a high correlation between data collected using the above recommendations and project site conditions (e.g., species diversity, temporal and spatial use, etc.) despite constraints that each unit samples a small amount of area (Weller 2007, Collins and Jones 2009). Please refer to Weller (2007) for additional specifics regarding the deployment of passive units on met towers.

5. Analysis of Data –Analysis of bat calls should only be performed by experienced personnel. Species identification should be made whenever possible; however, calls should at a minimum be identified to a frequency grouping (e.g., 25 kHz, 40 kHz, etc.).

   For each unit deployed report the total number of calls, number of identifiable calls, total number of survey nights, number of species detected, scientific name of species detected, and number and identity of frequency groups detected (e.g., 25 kHz, 40 kHz, etc.). The index of activity should be reported as the total calls per survey night per unit. The location (i.e., UTM), equipment aspect, microphone height, surveyor, and name of call analyst should also be reported.

A voucher call (i.e., representative call sequence) should be submitted for each species and frequency groups detected with the final report. The following supporting information should be supplied for each voucher call, location (i.e., UTM), date, time, scientific name of species detected, detector height and aspect, and name of call analyst.

Active Acoustic Surveys

1. Objective – Identify and quantify bat species presence below the rotor sweep zone.

2. Rationale – Results should be used primarily in conjunction with other survey methods (e.g., live capture). These types of surveys can be used to identify and prioritize additional survey locations, enhance identification of species (i.e., for those species that are not easily captured), and target areas that concentrate bat activity (e.g., foraging). For active acoustic survey recommendations that address broader objectives see Hester and Grenier (2005).

3. Equipment – The same equipment used for passive acoustic monitoring should be used for active acoustic monitoring. External display devices (e.g., laptops or PDA) can improve the observer's ability to collect high quality calls.

4. Application – Active acoustic monitoring should begin ½ hr before sunset and continue for at least 2½ hours. Personnel should attempt to follow bats in flight during the entire survey period. Care should be taken to collect long call sequences, whenever possible, to facilitate species identification. Avoid selecting survey sites near areas that reduce an observer's ability to hear bats (e.g., high ambient noise).

   Mobile (i.e., roaming or vehicle transects) acoustic surveys has the potential to quantify bat species and relative abundance below the rotor sweep zone across larger landscapes. This method collects bat calls while travelling a predetermined motorized route. There is no established methodology for this type of survey and individuals that are considering using this technique should consult qualified individuals before initiating surveys to ensure that the surveys are conducted in a robust manner to maximize inference.

5. Analysis of Data – Refer to Passive Acoustic Surveys – Analysis of Data.

Live Capture

1. Objective – Obtain demographic information (e.g., sex, age, reproductive status, etc.) of bats using near ground (< 20 m) habitats (i.e., below the rotor sweep zone) that cannot be obtained through acoustic monitoring.

2. Rationale – Results should be used primarily in conjunction with other survey methods (e.g., active acoustic). This type of survey can be used to prioritize additional surveys, enhance efforts to positively identify species that are hard to identify through acoustic monitoring, and target areas that concentrate bat activity (e.g., foraging areas). For live

capture survey recommendations that address broader objectives see Hester and Grenier (2005).

3. Equipment – A Chapter 33 Scientific Collection Permit is required by the Wyoming Game and Fish Department for live capture surveys. All individuals that will be handling bats should have their rabies prophylaxis. Mist nets and triple high mist nets are the most common equipment used for live capture of bats in Wyoming. The use of harp traps is more limited in Wyoming because of the high proportion of open landscapes. A more comprehensive discussion on additional equipment required for live captures can be found in Hester and Grenier (2005).

4. Application – Mist nets can be deployed successfully in almost any location where bats are expected to fly, and are highly effective for capturing bats at ground, sub-canopy, and canopy levels (i.e., below the rotor sweep zone). Identify productive sites by conducting acoustic surveys in advance. Capture success is usually highest near areas that concentrate use (e.g., water sources, foraging sites, and flyways [i.e., forest gaps, trails, and mountain ridges]).

   Surveys should be performed between June 1 and August 30. Each netting site that is identified in the project area should be surveyed at least 3 times during the field season. Nets should be set up ½ hour prior to sunset and be open for at least 2½ hours. Bats should only be processed by experienced individuals to reduce potential injury to bats. Please refer to Hester and Grenier (2005) for handling, holding, and processing bats in Wyoming.

5. Analysis of Data –For each survey occasion report the total number of bats captured, sex ratio, age ratio, site description, date, time, location, beginning and ending weather conditions, moon phase, time nets open/closed. Report also the mean catch per unit effort (i.e., number of bats captured per unit of survey time) for each site. For each bat captured species, sex, age, time of capture, ear length, forearm length, weight, reproductive status, and body condition should be reported.

Carcass Search

1. Objective – Identify and quantify bat species mortality after construction of turbines.

2. Rationale – The results of post-construction carcass searches are used to estimate mortality rates of bats at wind energy development sites.

3. Equipment – The WYBWG recommends searchers have their rabies prophylactic vaccination prior to conducting carcass searches to minimize risk associated with handling dead or wounded bats. A Chapter 33 Scientific Collection Permit is also required by the Wyoming Game and Fish Department for all personnel planning to collect bat carcasses.

4. Application – Carcass searches should be conducted weekly during two periods (Apr 15 – Jun 15) and (Aug 1 – Sept 30). More intensive carcass searches may be conducted if

necessary. We recommend that a subset of carcasses collected be submitted to the Wyoming Game and Fish Department as voucher specimens. Remaining carcasses (that likely remain attractive to scavengers) should be used to determine searcher efficiency and disappearance rates (Kerns 2005, Arnett et al. 2008). Carcass searches should be conducted in a robust method and estimates should correct for disappearance rates and searcher efficiency (Arnett et al. 2009, Baerwald et al. 2009).

5. Analysis of Data – Report age, sex, species, total number of killed and wounded bats found, and an estimate of bat mortality (Arnett et al. 2009, Baerwald et al. 2009). Reporting procedures for the Wyoming Game and Fish Department Chapter 33 Scientific Collection Permits must also be followed.

Table 1: The following matrix was developed by the Wyoming Bat Working Group to facilitate survey selection for bats within proposed wind project sites. The matrix recommends pre- and post-construction survey methods and identifies relevant actions (e.g., timing, permits, etc.) for conducting surveys in Wyoming.

Recommended Pre-Construction Survey Methods					
Survey Type	**Objectives**	**Timing**	**Permits**[1]	**Training**	**Comments**
Habitat Evaluation	Quantify existing habitat.	Anytime	None		
Passive Acoustic	Quantify bat activity in the rotor sweep area.	April 15 – October 15	None	Call interpretation	Provide copies of calls to WGFD/WYNDD[2]/Lead Agency.
Active Acoustic	Supplemental information for live capture and passive acoustic.	June 1 – August 31	None	Call interpretation	Provide copies of calls to WGFD/WYNDD/Lead Agency.
Live Capture	Collect demographic information on bats	June 1 – August 31	Chapter 33	Bat handling and identification.	Provide copies of calls to WGFD/WYNDD/Lead Agency.
Recommended Post-Construction Survey Methods					
Survey Type	**Objectives**	**Timing**	**Permits**[1]	**Training**	**Comments**
Habitat Evaluation	Quantify changes in habitat	Anytime	None		
Passive Acoustic	Quantify bat activity in the rotor sweep area	April 15 – October 15	None	Call interpretation	Provide copies of calls to WGFD/WYNDD/Lead Agency.
Carcass Search	Quantify bat species that are being impacted.	April 15 – June15 August 1 – September 30	Chapter 33		Provide some specimens

[1] - Some federal land management agencies require permits for performing surveys. Please coordinate with the appropriate agency to ensure regulatory compliance.

[2] Wyoming Natural Diversity Database

Passerines and Raptors

Each proposed wind energy project is site-specific with local differences in avian species present, season and type of use, habitat, topography, weather patterns, and site development potential. Appropriate site selection for wind energy development is key in preventing negative impacts to birds. In addition, planning a wildlife-friendly wind energy development can lower long-term costs and potential liabilities under Federal wildlife protection laws, such as the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, and the Endangered Species Act. Therefore, detailed planning and survey efforts prior to construction will identify problems that may occur, how to circumvent these problems, how to mitigate problems that cannot be avoided, and identify sites that are unsuitable for development. We encourage developers to meet as soon as possible with the USFWS to get their input relating to potential impacts to migratory birds and raptors.

We recommend the following monitoring recommendations for pre-, during, and post-construction should be implemented when wind energy projects are proposed for or occur in areas occupied by breeding, foraging, and migrating birds, especially Species of Greatest Conservation Need. These should serve as a starting point until the Wyoming Partners In Flight Bird Conservation Plan update has been completed, which will include a more comprehensive set of best management practices and recommendations for siting, monitoring, mitigation, and research to minimize the impacts of wind energy development on birds.

In general, we recommend surveys be conducted for a minimum of 2 years prior to construction and a minimum of 3 years post-construction to be consistent with recommendations for other wildlife species (i.e., bats, sage-grouse and big game).

1. Perform a risk assessment reconnaissance survey that includes a review of existing wildlife databases, maps, literature, reports, and aerial photographs, as well as discussions with wildlife experts, to determine concerns and potential conflicts with birds occurring in the proposed development area. Results may indicate that certain sites are unsuitable for wind energy or that the size of the project may need to be scaled back.
2. Until a sufficient body of scientific research is developed nationwide to determine acceptable certainty regarding the level of disturbance or displacement of birds due to wind energy developments in general, wind project proponents are expected to implement appropriate monitoring to help answer this question on a case-by-case basis in Wyoming.
3. We recommend conducting pre-construction surveys within the project area and within 1 mile of the project boundary using the techniques described below. Data should document the species and number of birds observed, their movements and distribution, the proportion of birds occurring within the rotor sweep area, and altitude and orientation of flight during various weather conditions.

Point Counts

a) Conduct spring and autumn point- count surveys to detect resident and migrant passerines, and other localized birds. Fixed-radius point count surveys (Reynolds et al. 1980) should be conducted weekly over a 12-week period in spring and again in fall in order to detect early, mid, and late migrants. Point count surveys should begin in April to late June (depending on location and elevation) to detect breeding songbirds. Points should be randomly distributed across the proposal area or strategically placed to assess data at turbine locations (depending on the proposed development design). A sufficient number of points should be incorporated in the design to enable statistical power in the analyses. Surveys should begin ½ hour before official sunrise and end approximately 4 to 5 hours after official sunrise (USGS 1998) for breeding birds; and occur at other times during the day for other birds. UTM coordinates of the count site, number of birds detected, time, and species should be recorded. Surveys should be conducted for 20 minutes at each point to optimize surveying time and number of stations (points) in the survey (Reynolds et al. 1980). Sufficient distance between point count stations should be considered to avoid duplication of counts (Alldredge et al. 2006, Buckland et al. 2009).

b) Winter surveys- A minimum of 2 surveys should be conducted per season: early winter from 1 December – 15 January and late winter from 16 January – 28 February. Follow point count protocol. Species, number of birds detected, time, primary habitat, and UTM coordinates of each sighting should be recorded.

c) Depending upon survey results, additional surveys for sensitive avian species (e.g. SGCN) present within sensitive habitats (e.g. wetlands, riparian areas) may be suggested. Survey methodology will depend on the species present.

Raptors

a) We recommend one day-long survey for raptors should occur each week during both the spring and autumn 12-week period of bird point counts. UTM coordinates of the count site, location relative to the project, number of birds detected, sex and age class (if possible), time, species, behavior, altitude, flight direction, and primary habitat should be recorded. Any observations of large flocks of non-raptors (waterfowl, shorebirds, swallows, cranes, etc.) should also be recorded.

b) We recommend area search surveys occur during the breeding season to locate raptor nests. Surveys to locate raptor nest structures within suitable habitat (trees, rock outcrops, hillsides, etc.) can be conducted either aerially in a low-flying fixed-wing aircraft or helicopter, or on foot along transects that are no more that ½ mile apart (depending on topography and physical features) or by driving along public roads and accessible private roads that are within 1.0 miles of the project area. In general, the method used will depend on the size and accessibility of the proposed project site. However, if ground surveys cannot provide comprehensive coverage and accurate locations of nests within the project area, aerial surveys should be implemented. UTM coordinates, nesting substrate, status (occupied, unoccupied, incubating adult, young in the nest), and primary habitat should be recorded for each nest located. See the Table 2 for species-specific survey dates.

Carcass Search and Collection

a) Conduct carcass collection surveys for the duration of post-construction monitoring; typically 3 years (appropriate state and federal permits are required for carcass salvage). The extent (e.g. sub-sample versus complete sample of developed area), frequency (e.g. daily, weekly, biweekly), and seasonality (e.g. migration, breeding season) should be determined prior to the initiation of the surveys and will be influenced by site-specific characteristics such as terrain and vegetation type, bird population levels, size of the development, and the level of impact the development has on birds in the area. All carcasses should be collected and identified. Annual fatality rates per MW or per turbine should be estimated. Actual fatality rates at wind turbines are incompletely observed and must be adjusted by at least these two factors: carcass removal by scavengers and searcher efficiency rates. Scavenger removal trials should be conducted at each site to determine the length of time it takes scavengers to find and remove carcasses. This rate can then be factored into statistical estimations of fatality rates to provide more accurate estimates (for protocols see Smallwood 2007).

b) Searcher efficiency trials should be conducted at each site to account for differences in vegetation and individual detection rates. This rate can then be factored into statistical estimations of fatality rates to provide more accurate estimates (for protocols see Kunz et al. 2007).

Table 2: Diurnal Raptor Survey Dates (2a) and Disturbance Free Dates (2b)

Species	March			April			May			June			July			August		
	1	15	31	1	15	30	1	15	31	1	15	30	1	15	31	1	15	30
American Kestrel																		
Bald Eagle																		
Cooper's Hawk																		
Ferruginous Hawk																		
Golden Eagle																		
Merlin																		
Northern Goshawk																		
Northern Harrier																		
Osprey																		
Peregrine Falcon																		
Prairie Falcon																		
Red-tailed Hawk																		
Sharp-shinned Hawk																		
Swainson's Hawk																		

Darkened block indicates best times to detect birds in courtship (early dates) or with young in the nest when adults will be conspicuous (later dates). For accipters, Merlins, and Peregrine Falcons, detectability during courtship is variable, with some pairs almost impossible to detect.

………. : Indicates periods for species with conspicuous nests during which surveys can also be conducted effectively.

Note: Dates may vary slightly by latitude, altitude or other factors affecting phonology and should be adjusted depending on field conditions.

Table 2b: continued

WGFD DISTURBANCE-FREE DATES AND BUFFERS FOR RAPTORS		
SPECIES	**DISTURBANCE-FREE DATES**	**DISTURBANCE-FREE BUFFER**
Bald Eagle	February 15 – August 15	½ mile
Ferruginous Hawk	March 1 – July 31	1 mile
Golden Eagle	January 15 – July 31	½ mile
Merlin	April 1 – August 15	½ mile
Northern Goshawk	April 1 – August 15	½ mile
Peregrine Falcon	March 15 – August 15	½ mile
Prairie Falcon	March 1 – August 15	½ mile

Note: Disturbance-free dates include territory establishment through fledging.
Note: Additional considerations include line of sight, visibility, type of disturbance activity, location of disturbance above or below the occupied nest, and specific situations.

Sage-Grouse

The WGFD has provided the WGFC with a summary of the current understanding of potential impacts of wind development on sage-grouse. While much additional research needs to be conducted, the WGFD has concluded that the best information currently available indicates a risk of significant population level impacts to sage-grouse if wind development occurs in a sage-grouse core area. In addition, the U.S. Fish and Wildlife Service has notified the WGFD (letter dated July 7, 2009 from Brian Kelly to Director Ferrell), that "constructing wind farms in core areas, even for research purposes, prior to demonstrating that it can be done with no impact to sage-grouse, negates the usefulness of the core area concept as a conservation strategy and brings into question whether adequate regulatory mechanisms are in place to protect the species." Having regulatory mechanisms is a key factor used by the USFWS in determining whether a species should be listed as endangered or threatened. The WGFD interprets the USFWS letter as a clear signal that state authorization of wind development in a sage-grouse core area, without clear demonstration from the project proponent that the activity will not cause a decline in sage-grouse populations, leaves the state in a precarious position to demonstrate that adequate regulatory mechanisms are in place to conserve sage-grouse.

Based on our current understanding of potential conflicts between sage-grouse and wind development, the WGFC directed the WGFD to recommend to the WISC that no wind turbines be constructed in sage-grouse core area without clear demonstration from the project proponent that the activity will not cause a decline in sage-grouse populations. W.S. 35-12-110(c) allows WGFD to recommend appropriate conditions that might be included in the Industrial Siting Permit. The WGFC has directed the WGFD to continue to explore, through research outside of sage-grouse core areas, what impacts will occur to sage-grouse from wind energy development. That research may result in future revisions to these recommendations and WGFC policies.

The following recommendations for wind development projects in regard to sage-grouse baseline data collection and monitoring should occur assuming a multi-state industry supported research program is operational to determine sage-grouse response and population performance to wind development. If the research program is not operational additional research actions will be recommended for individual projects. Research response variables should include population and habitat parameters such as nesting success, chick survival, lek attendance, and any changes in distribution, movements, and habitat use.

For projects that will occur <u>outside</u> a sage-grouse core area we recommend the following monitoring protocol:

- Conduct lek counts (using WGFD protocol) within a 2 mile buffer of the proposed project area boundary.
- Map habitat within a 2 mile buffer area of the project boundary.
- Compare lek counts with a suitable nearby reference area.
- We recommend 2 years pre-construction data collection followed by 3 years post construction with annual review thereafter as determined by the assigned Technical Advisory Committee (TAC).

Big Game

The following baseline data and monitoring recommendations for wind development projects in regard to big game should occur assuming a multi-state industry supported research program is developed that measures big game responses to wind development. If the research program is not operational additional research actions will be recommended. Research response variables should include population and habitat parameters such as fawning/calving rates, neonate survival, and any changes in distribution, movements, and habitat use.

If the project occurs on lands designated as crucial winter range, identified parturition areas, or will bisect known migration corridors, we recommend the following to provide baseline data and post-development data that will help identify any associated impacts and provide for future mitigation options for affected big game species:

- Radio collar a representative sample (to be determined in coordination with WGFD) of the female portion of the affected herd(s).
- Collect telemetry relocation data 2 years prior to development and 3 years post development to determine habitat use, identify migration corridors, and identify changes in habitat use and population demographics.
- Collect and compare these parameters on a suitable nearby reference area.

These data should be collected, analyzed, and provided in an annual report to WGFD. At the end of three years, if it is determined that significant avoidance of important habitats is occurring or population parameters are being negatively affected by the wind energy development, a mitigation plan should be developed in collaboration with WGFD to compensate for that impact.

Amphibians

In general, we recommend baseline monitoring be accomplished through incidental observations while performing other wildlife surveys. Incidental observations will allow for trend data, which could elucidate possible shifts in species assemblages resulting from energy development. In addition to generalized incidental monitoring, surveys may be recommended on specific SGCN.

SGCNs include the following species: boreal toad, Wyoming toad, wood frog, Columbia spotted frog, Great Basin spadefoot, plains spadefoot and northern leopard frog. Additional information on these species can be found in Table 3.

If no SGCN is known to occur within or near a wind development project, we recommend that incidental observations be recorded for amphibian species. All amphibians encountered incidentally during wildlife surveys should be documented. Species, geographic coordinates (preferably decimal degrees or UTM), date, age class (adult, juvenile, larval, or egg), general vegetation type, and general comments are requested for each observation. Observations will be collected while performing other wildlife surveys within the study area. We recommend that 2 years of preconstruction monitoring and 3 years post construction monitoring be completed. A two year preconstruction time frame helps ensure that surveys can be conducted in a wide range of environmental conditions. Many species that are rare or cryptic may easily be overlooked with only one year of survey. If a SGCN is discovered during the incidental observations additional monitoring may be recommended (Figure 1).

<u>Species of Greatest Conservation Need (SGCN)</u>

If a SGCN is known to occur or has the potential to occur within or near a wind development project, additional monitoring is recommended (Figure 1).

- The monitoring of SGCNs starts with creating habitat maps for a wind development project. In conjunction with mapping terrestrial habitats, the following water features will also be mapped: ephemeral drainages, perennial waters, vernal pools and playas.

- If amphibian habitat is not found during mapping, no additional monitoring will be needed. However, incidental monitoring is recommended.

- However, if SGCN amphibian habitat is found, we recommend the project developer contact the Department to discuss if the project can be designed so that amphibian habitat can be avoided. To protect SGCN amphibian habitat, the Department recommends a 500 meter buffer. This buffer was designed to incorporate SGCN average home range and migration distances (Hammerson 1999, Ernst and Ernst 2003, Werner et al. 2004, Lannoo 2005, Parker and Anderson 2007). If the project is designed such that habitat disturbance is located greater than 500 meters from water features, including ephemeral drainages, perennial waters, vernal pools and playas additional monitoring will not be needed. However, incidental monitoring is recommended.

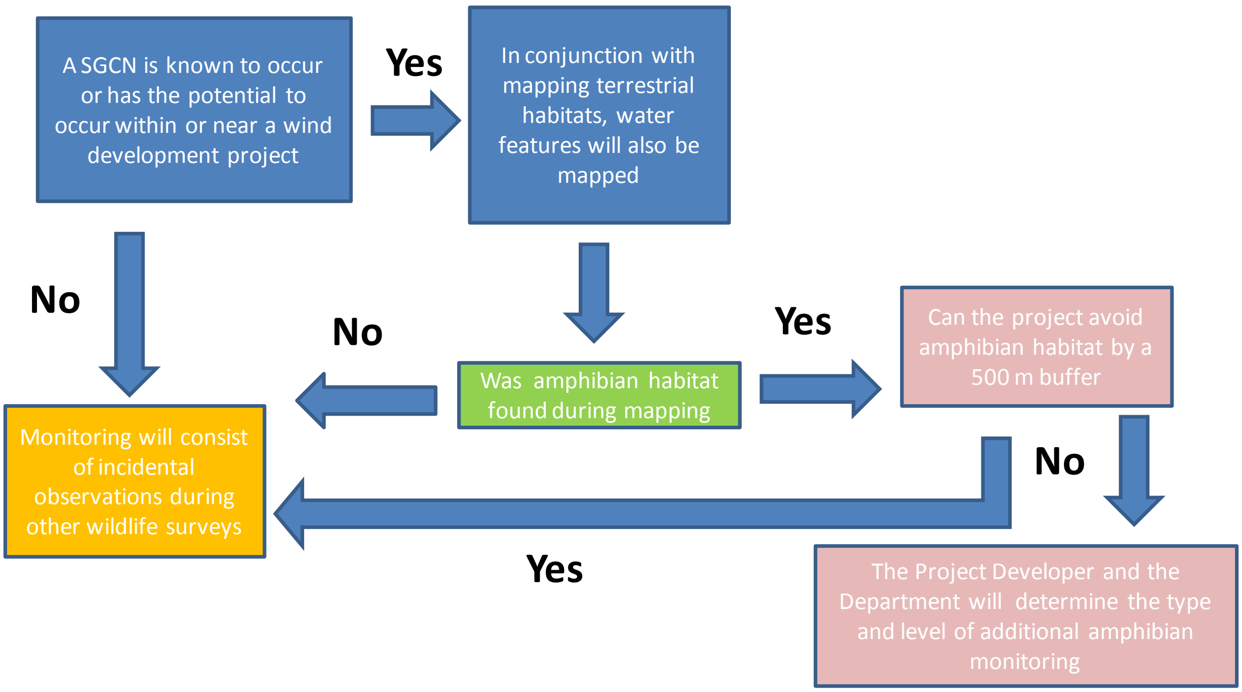
- If SGCN amphibian habitat cannot be avoided, the project developer and the Department will determine the type and level of additional amphibian monitoring needed.

- Because of breeding chronology and the secretive nature of some species, two years of survey are recommended before development begins. During predevelopment surveys, important amphibian areas (such as breeding sites) should be designated for avoidance during construction. Surveys should be conducted at least three years post-construction to determine possible effects of development on amphibian species.

- Mitigation may be recommended if sensitive habitats or species are impacted.

- Reclamation plans of disturbed habitat sites for these species should be developed.

Figure 1. Decision Tree for Amphibian Monitoring Recommendations Associated with Wind Energy Development



Reptiles

If no SGCN is known to occur within or near a wind development project, we recommend that incidental observations be recorded for reptile species. All reptiles encountered incidentally during wildlife surveys should be documented. Species, geographic coordinates (preferably decimal degrees or UTM), date, age class (adult, or juvenile), general vegetation type, and general comments are requested for each observation. Observations will be collected while performing other wildlife surveys within the study area. We recommend that 2 years of preconstruction monitoring and 3 years post construction monitoring be completed. A two year preconstruction time frame helps ensure that surveys can be conducted in a wide range of environmental conditions. Many species that are rare or cryptic may easily be overlooked with only one year of survey. If a SGCN is discovered during the incidental observations additional monitoring may be recommended (Figure 2.)

There are three reptile SGCN; midget faded rattlesnake, northern tree lizard, and Great Basin gophersnake. All three species occur in southwest Wyoming. Additional information on these species can be found in Table 3. If a wind project is located in habitat that is known to have these species or has the potential to occur within or near the project, additional monitoring is recommended.

- If reptile habitat, hibernacula and potential hibernacula habitat is not found during two years of preconstruction monitoring, no additional monitoring will be needed. However, incidental monitoring is recommended.

- However, if SGCN reptile habitat is found, we recommend the project developer contact the Department to discuss if the project can be designed so that reptile habitat can be avoided. To protect SGCN reptile habitat, hibernacula and potential hibernacula habitat, the Department recommends a 500 meter buffer. This buffer was designed to incorporate SGCN average home range and migration distances (Ernst and Ernst 2003, Hammerson 1999, Lannoo 2005, Parker and Anderson 2007, Werner et al. 2004). If the project is designed such that habitat disturbance is located greater than 500 meters from hibernacula or potential hibernacula habitat additional monitoring will not be needed. However, incidental monitoring is recommended.

- If SGCN reptile habitat, hibernacula and potential hibernacula habitat cannot be avoided, an additional three years post construction monitoring is recommended.

- Mitigation may be recommended if sensitive habitats or species are impacted.

Midget Faded Rattlesnake, Great Basin Gophersnake, and Northern Tree Lizard Survey Protocol - Design of Survey

1. We recommend that before a survey is done, that the survey team spend a day with Wyoming Game and Fish personnel to ensure that the survey method is being used correctly.

2. Delineate rock outcroppings with a Southern aspect (SE, S, SW or 120^o- 240^o) using aerial photography, Google Earth, or other available GIS data layers within the proposed project area. Any rock outcropping above 7,500 feet or with a Northern aspect may be excluded from the survey design. Although hibernacula for these species are historically observed below 7,000 feet, it would be prudent to search slightly higher elevations to ensure the absence of midget faded rattlesnake, Great Basin gophersnake, or northern tree lizard populations. The proposed elevation would help prevent the possible exclusion of males migrating away from hibernacula during summer months, or other fringe hibernacula.

3. A total of three surveys should be performed from late spring through early fall (mid May through mid September) on delineated rock outcroppings. Surveys can only be performed when daytime temperatures exceed 55^oF for a week or more. At least two surveys should be conducted between July 15^{th} and September $15^{th.}$ Surveys may be performed in spring and fall months at any time during the day. However, during summer months when daytime temperatures exceed 85^oF, surveys should be limited to morning and early afternoon time periods (8:30AM to 1:00PM).

4. Each delineated rock outcropping should be surveyed for a total of 1 man-hour per km^2 of suitable habitat (i.e. One person should survey suitable habitat for 1 hour, while two people could survey the same area for 30 minutes). For midget faded rattlesnakes, it is recommended that surveyors wear protective gear or clothing while conducting surveys to maintain safety. This could include any one of the following items: snake boots, snake gaiters, or snake chaps. When climbing rocks, surveyors should also verify that all handholds snake free. Observers should listen closely for snakes rattling while conducting the survey. Some snakes will not be easily observable, and may give their locations away by this behavior. Effort should be made to avoid flipping rocks. This activity could alter reptile habitat. Surveyors are recommended to inspect crevices, fissures, and overhangs within rock outcrops. All herpetafauna found during the course of a survey should be noted on observational datasheets and photographed.

   Upon observation of a reptile or identifiable shed skin, the surveyor should fill out the correct datasheet and collect a photo voucher of the specimen. A GPS point (UTM NAD 83 zone12) should be taken at the observed location. Effort should be made to not disturb the observed reptile.

Figure 2. Decision Tree for Reptile Monitoring Recommendations Associated with Wind Energy Development

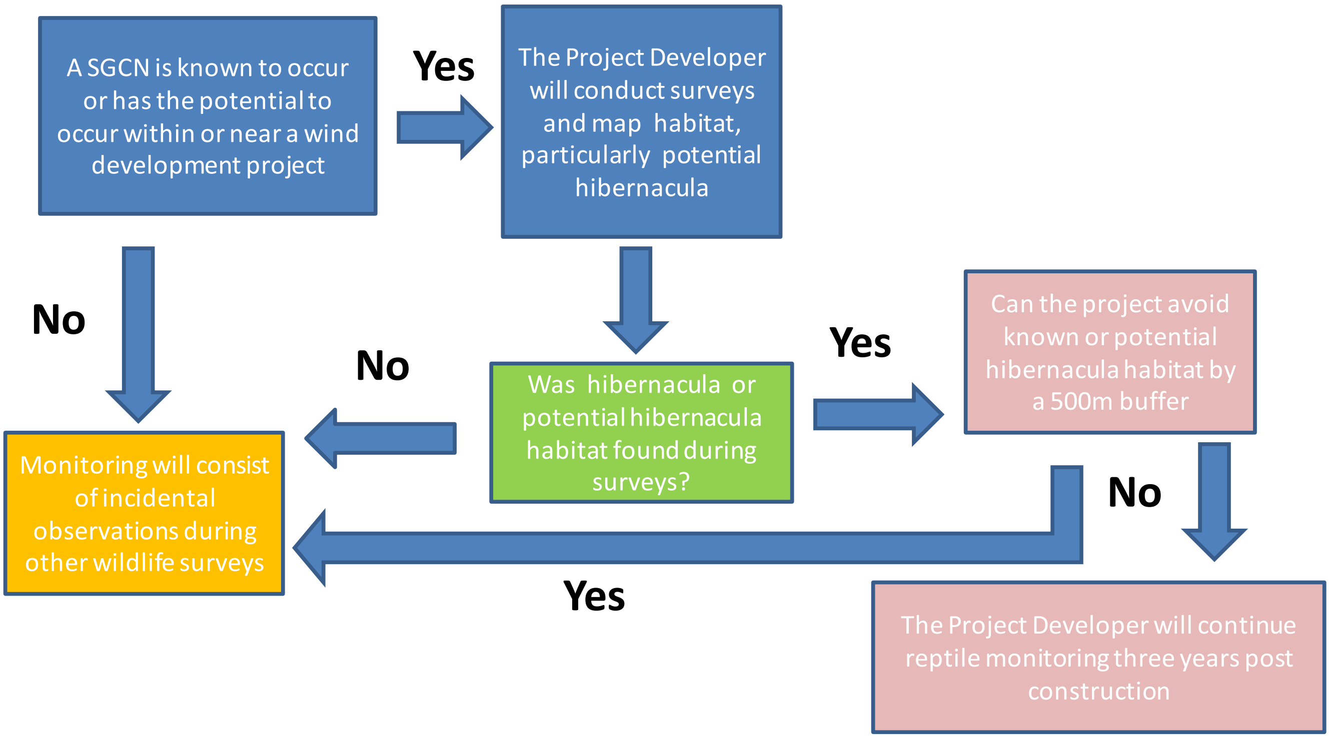


Table 3: Amphibians and Reptiles – SGCN 2005 Species Specific Monitoring

Amphibians and Reptiles which will need species specific monitoring	SGCN Rank 2005	Habitat	Range
Boreal Toad	NSS1	Wet situations in the foothills, montane and subalpine life zones. Seldom found far from water	Mountains west of Continental Divide, Medicine Bow Mountains
Wyoming Toad	NSS1	Floodplains, ponds, small seepage lakes in the shortgrass communities of the Laramie Basin	Laramie Basin. Only known wild populations near Centennial, WY
Northern Tree Lizard	NSS2	Rocky Cliffs in sagebrush desert	Upper Green-Flaming Gorge Watershed
Midget Faded Rattlesnake	NSS2	Sagebrush communities and rocky outcrops	SW Wyoming with population focused near the towns of Green River and Rock Springs.
Wood Frog	NSS3	Beaver ponds, streams, and lakes in montane zones.	Medicine Bow and Bighorn Mountains
Great Basin Gophersnake	NSS2	Sagebrush communities and desert habitats	SW Wyoming
Columbia Spotted Frog	NSS4	Ponds, sloughs, and streams in the foot hills and montane zones	Mountains west of Continental Divide, Bighorn Mountains

Table 3: Continued

Amphibians and Reptiles which will need species specific monitoring	SGCN Rank 2005	Habitat	Range
Great Basin Spadefoot	NSS4	Sagebrush communities mostly in the Wyoming Basin and Green River Valley	Low elevations mainly west of Continental Divide
Plains Spadefoot	NSS4	Grasslands and sagebrush communities in the plains zones	Low elevations mainly east of Continental Divide
Ornate Box Turtle	NSS4	Sandy open grasslands	Along Lower North Platte adjacent to Nebraska
Northern Leopard Frog	NSS4	Permanent water in the plains, foothills, and montane zones. Prefers marshes and beaver ponds.	Statewide

* All species are considered SGCN.
Species Information from Baxter and Stone 1985.

Aquatics

The WGFD recognizes that proposed wind projects will differ in their potential for impacting stream channels and aquatic species. A one-size-fits-all approach to aquatic and geomorphology impact avoidance or monitoring would not adequately address the variability of each project or its location. Impact potential depends on elevation, aspect, slope, project size, soil type, vegetative cover, road density, distance from ephemeral or permanent water sources, and the presence of other (non-wind energy related) soil perturbations in the watershed. The approach described below is recommended to help wind development proponents identify the potential for sediment impacts to aquatic habitats, address that potential during project development, and monitor for impacts in cases where aquatic resources may be in jeopardy. Based on site-specific conditions the monitoring of culverts, roads with 5% slope or greater and geomorphological studies of waterways may be recommended.

The purpose of monitoring culverts and roads with 5% or greater slope is to determine the presence, absence and/or extent of cumulative impacts resulting from changes to the upland surface hydrology, erosion and deposition, to ensure that culverts are functioning as designed and are being maintained and to ensure that the long-term BMPs that were installed are still functioning and are being maintained.

The purpose of geomorphological monitoring activities is to determine the presence, absence and/or extent of cumulative impacts resulting from changes to upland surface hydrology, erosion and deposition and the potential for impacting habitats important to fish, macroinvertebrates, reptiles and amphibians. The geomorphological monitoring WGFD is recommending follows the Watershed Assessment of River Stability and Sediment Supply (WARSSS) methodology outlined in Rosgen (2006). The following descriptions of the WARSSS methodology are quotes from Rosgen (2006) and are provided here as background information:

Watershed Assessment of River Stability and Sediment Supply (WARSSS) is a geomorphology-based procedure for quantifying the effects of land uses on sediment relations and channel stability (Pg. 1-1).

WARSSS identifies the hillslope, hydrologic and channel processes responsible for significant changes in erosion, sedimentation and related stream channel instability. It uses a three-phase assessment process to quickly separate areas into low-, moderate- and high-risk landscapes and / or river reaches (Pg. 1-2).

The results of the WARSSS assessment reveal significant, adverse influences of land uses on stream channel stability, sediment sources and sediment yield that may affect the material beneficial uses of rivers and streams. WARSSS data can be used for watershed planning, “clean sediment” Total Maximum Daily Load (TMDL) assessments for non-point source pollution and stability analysis for river restoration (Pg. 1-2).

The Reconnaissance Level Assessment (RLA) is the first and most general phase of the three WARSSS assessment phases. It provides a broad overview of the landscape while focusing on processes that may affect sediment supply and channel stability (Pg. 3-1). Performing a Reconnaissance Level Assessment (RLA) requires one to a few office days.

Sensitive landscapes, potentially unstable stream systems and sediment-generating land use activities need to be identified, prioritized and evaluated for potential impacts at a level of detail beyond the initial RLA analysis. The Rapid Resource Inventory for Sediment and Stability Consequence (RRISSC) provides this finer level of analysis (Pg. 4-1). Performing the Rapid Resource Inventory for Sediment and Stability Consequence requires about 1 week depending on data availability.

The Prediction Level Assessment (PLA), the most detailed level of the WARSSS methodology, is reserved for sub-watersheds and river reaches previously identified as being at high risk for sediment and / or river stability problems. The PLA compares direction, rate, nature and extent of departure of existing sediment and channel stability to a reference condition typical of stable, natural land and stream conditions (Pg. 5-1). Performing a PLA, would require at least 4 sampling occasions/reaches (before/after project implementation, upstream/downstream of project area).

A Rosgen Level II assessment consists of a morphological description of stream channel conditions at a reach. A Level III is synonymous with the PLA and includes all the aspects of a Level II assessment plus assessments of river stability, bank erosion, sediment competence, and sediment transport capacity.

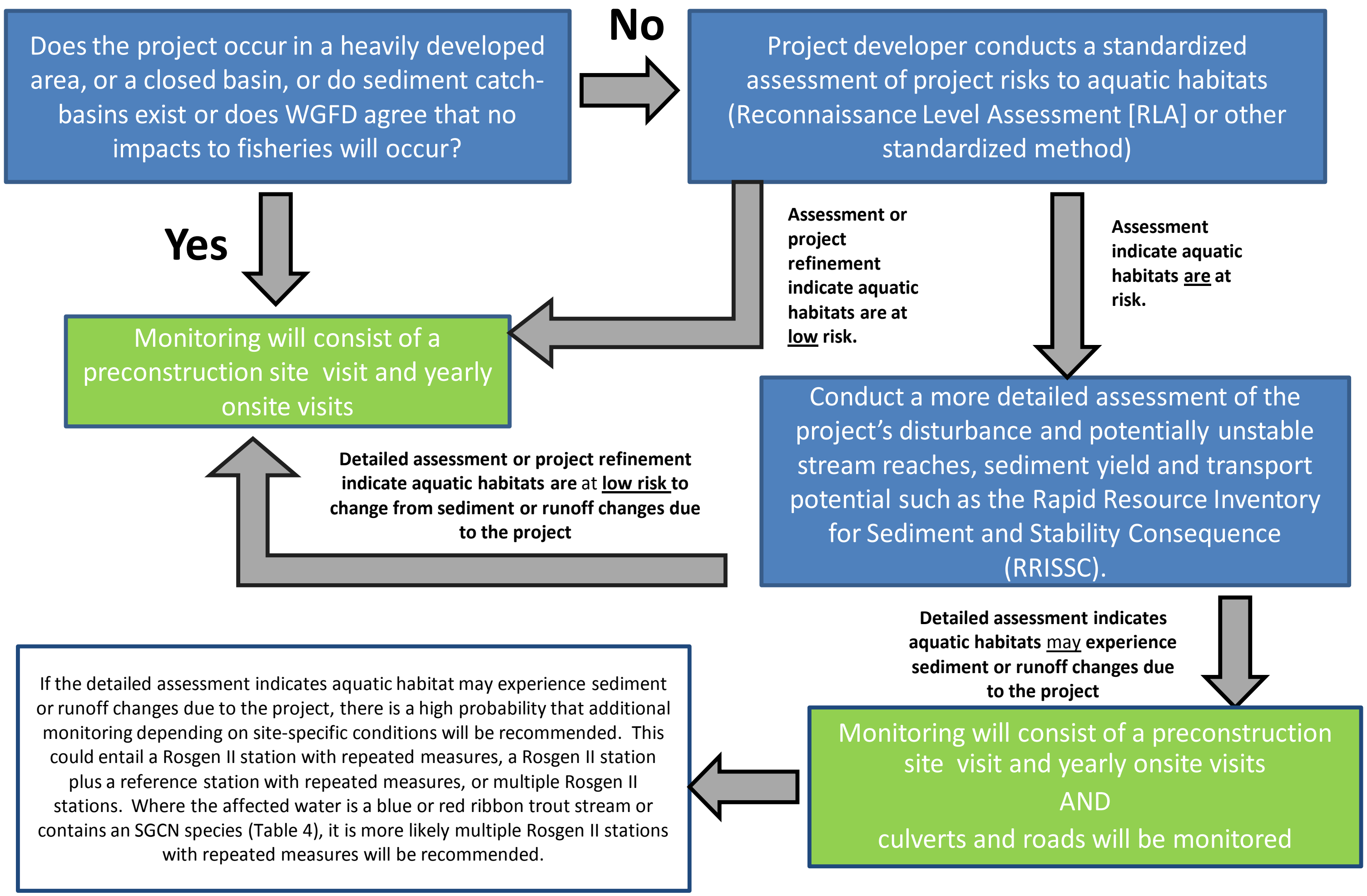
Recommended Approach

To identify and avoid impacts to aquatic resources, a multiphase approach is recommended (Figure 3). The approach includes varying levels of effort and assurance of impact avoidance depending on the apparent risk to aquatic habitats.

As indicated in Figure 3, very minimal effort is recommended if the wind project is proposed within an existing heavily developed area (e.g. an existing oil or gas field), is located within a closed basin (i.e. water cannot reach a perennial water body), or if sediment catchments exist on the ephemeral drainage(s) such that sediment could never reach a permanent water course, or the project developer and the Department agree that no impacts to a fisheries will occur. In these cases, WGFD recommends simply a pre-construction onsite visit followed by yearly onsite visits (Figure 3). The purpose of the yearly onsite visits is to ensure that the BMPs, as outlined in the Storm Water Prevention Plan, are working as designed. If problem/s are occurring, WGFD will provide recommendations to fix the problem/s. If the problem/s is not fixed in a timely manner, WGFD may recommend additional monitoring be conducted. Such yearly site visits are recommended for all wind energy developments.

Figure 3. Decision Tree for WGFD Aquatic Monitoring Recommendations

This decision tree will be used to develop wind energy recommendations to the ISC . The suggested assessments Reconnaissance Level Assesment (RLA) and Rapid Resource Inventory for Sediment and Stability Consequence (RRISC) and monitoring approaches are from Rosgen, D. 2006, Watershed Assessment of River Stability and Sediment Supply (WARSSS).



- If the project proponent cannot demonstrate the proposed development is within an existing heavily developed area (e.g. an existing oil or gas field), is in a closed basin, or has substantial sediment basins, the WGFD recommends the project proponent conduct a standardized assessment to identify low, medium, and high risk landscapes and/or stream reaches (via a Reconnaissance Level Assessment [RLA] preferably or other standardized method to determine where critical areas exist down slope from a proposed project site (Figure 3).

- If the reconnaissance assessment indicates **low risk** to stream reaches or project refinements are implemented so that aquatic habitats **are at low risk**, monitoring will consist of a preconstruction site visit and yearly onsite visits (Figure 3). Examples of project refinements are: additional BMP's that will prevent the movement of sediment into nearby waterways; avoidance/minimization measures, such as larger road offsets from channels; implementation of measures to mimic existing surface water runoff patterns; or site-specific engineering controls.

- If the assessment indicates aquatic habitats **are at risk**, we recommend a more detailed assessment of the project's disturbance and potentially unstable stream reaches, sediment yield and transport potential such as the Rapid Resource Inventory for Sediment and Stability Consequence (RRISSC) be conducted (Figure 3).

- If the detailed assessment indicates **low risk** to change from sediment or runoff changes due to the project or project refinements are implemented so that aquatic habitats **are at low risk**, monitoring will consist of a preconstruction site visit and yearly onsite visits (Figure 3). Examples of project refinements are: additional BMP's that will prevent the movement of sediment into nearby waterways; avoidance/minimization measures, such as larger road offsets from channels; implementation of measures to mimic existing surface water runoff patterns; or site-specific engineering controls

- If the detailed assessment indicates that aquatic habitats **may experience sediment or runoff changes** due to the project, then monitoring will consist of a preconstruction site visit, yearly onsite visits and culverts and roads will be monitored (Figure 3). There is a high probability that additional monitoring depending on site-specific conditions will be recommended (Figure 3). This could entail a Rosgen II station with repeated measures, a Rosgen II station plus a reference station with repeated measures, or multiple Rosgen II stations. Where the affected water is a blue or red ribbon trout stream or contains an SGCN species (Table 4), it is more likely multiple Rosgen II stations with repeated measures will be recommended.

Detailed Culvert, Road And Channel Monitoring Recommendations
Culverts

If a perennial stream is crossed as a result of a wind development project, stream crossings by roads should be adequately designed to allow fish passage at all flows. Crossing types in order of descending desirability to minimize aquatic impacts are a) bridge spans with abutments on banks, b) bridge spans with center support, c) open bottomed box culverts and d) round culverts with the bottom placed no less than one foot below the existing stream grade. Some level of monitoring may be recommended. The level of monitoring will be determined by what type of structure is used to cross the perennial stream. If the stream is crossed either with a properly designed bridge or bottomless culvert, monitoring will consist of a preconstruction onsite visit with yearly onsite visits. If a round culvert is used, we recommend that data from two Rosgen II stations (above and below culvert) be collected.

Perched culverts block fish passage and in most cases are unacceptable in any stream that supports a fishery. A perched culvert may be acceptable and recommended by the Department to protect an upstream fishery population i.e. cutthroat trout population or native non-game population.

The following are recommended references for the minimum guidelines for culvert sizing and placement: the BLM's Gold Book or the Forest Service Handbook 7709.56b.

1. Collect GPS coordinates or other location specific information for each culvert site
2. Collect pre-construction photographs of the planned culvert site; upstream and downstream
3. Collect construction photographs of the planned culvert site following construction phase roadway installation (temporary width) and following final roadway installation (permanent width).
4. Typical SWPPP monitoring and maintenance requirements will apply during construction phase of the project.
5. Collect post-construction photographs of the culvert site; upstream and downstream.
6. Following completion of final roadway and shoulder installation (permanent width), place a graduated fence post upstream and downstream of each culvert. The posts should have visible markings every 2" to provide a visual reference within each photograph. Fence posts should be placed within 50 feet of the culvert openings. Posts should be placed outside of the channel flow so they are not directly affected by storm flow events. Each fence post location will be referenced by GPS or other location specific information.
7. GPS or otherwise identify the site where photographs will be taken for the upstream and downstream view.
8. Following completion of final roadway and shoulder installation (permanent width), culverts and accompanying fence posts will be monitored/photographed a minimum two times a year (spring after snow melt and fall). We recommend that

the fall monitoring occur before September 15, so there will be sufficient time to review the photographs and remedy any problems before winter. Additional monitoring is recommended after a summer rainfall event/s accumulating greater than ½ inch of precipitation in an hour as measured at the nearest National Weather Service Monitoring point (if within 10 miles of the site) or at the Facility operations and maintenance building.

9. Make photographs available for WGFD review within 30 days.
10. Monitoring will continue for two-years post SWPPP release, and will be re-evaluated by Project Developer and WGFD for necessity following that period.
11. If monitoring shows that impacts are occurring, WGFD and the project developer will meet to discuss what corrective actions need to be taken to remedy the cause of the impact. If impacts are still occurring, additional monitoring maybe recommended.

If the photographs reveal observable changes from erosion or deposition, consultation between WGFD and Project Developer will occur within 30 days after WGFD receives the photographs.

Roads with 5% or greater slope

1. Collect GPS coordinates or other location specific information for each 5% roadway slope monitoring point
2. Collect pre-construction photographs of each 5% roadway slope monitoring site; upstream and downstream
3. Collect construction photographs of each 5% roadway slope monitoring site following construction phase roadway installation (temporary width) and following final roadway installation (permanent width).
4. Typical SWPPP monitoring and maintenance requirements will apply during construction phase of the project.
5. Collect post-construction photographs of the 5% roadway slope monitoring site; upstream and downstream.
6. Following completion of final roadway and shoulder installation (permanent width), place a graduated fence post midway down the 5% roadway slope and at the bottom of the slope in the drainage ditch or shoulder on the side of the road if no drainage ditch is installed. If drainage ditches are installed on both sides of the road, graduated fence posts will be placed in both drainage ditches. The posts should have visible markings every 2" to provide a visual reference within each photograph. Posts should be placed outside of the main flow channel so they are not directly affected by storm flow events.
7. Each fence post location will be referenced by GPS or otherwise identified.
8. GPS or otherwise identify the site where photographs will be taken.
9. Following completion of final roadway and shoulder installation (permanent width), fence posts will be monitored/photographed a minimum two times a year (spring after snow melt and fall). We recommend the fall monitoring occur before September 15, so there will be sufficient time to review the photographs and remedy any problems before winter. Additional monitoring is required after

a summer rainfall event/s accumulating greater than ½ inch of precipitation in an hour as measured at the nearest National Weather Service Monitoring point (if within 10 miles of the site) or at the Facility operations and maintenance building.

10. Photographs will be made available for WGFD review within 30 days.
11. Monitoring will continue for two-years post SWPPP release, and will be re-evaluated by Project Developer and WGFD for necessity following that period.
12. If monitoring shows that impacts are occurring, WGFD and the project developer will meet to discuss what corrective actions need to be taken to remedy the cause of the impact. If impacts are still occurring, additional monitoring maybe recommended.

If the photographs reveal observable changes from erosion or deposition, consultation between WGFD and Project Developer will occur within 30 days after the WGFD receives the photographs.

Channel Geomorphology

1) Perform the Reconnaissance Level Assessment (RLA) of the WARSSS methodology to identify sediment sources and existing channel stability problems.
2) For areas or reaches not excluded in step 1, perform the Rapid Resource Inventory for Sediment and Stability Consequence (RRISSC) to identify and clarify potential natural sediment and channel problem areas and to put potential project-related impacts in context.
3) Based on the results of the RLA and RRISSC, aquatic habitats will be identified either at low risk to change from sediment or runoff changes due to the project or aquatic habitats may experience sediment or runoff changes due to the project. At this stage, it is recommended the project proponent contact the Department to discuss the nature and extent of monitoring needed.
4) If the project will have a low risk to aquatic habitat, no additional monitoring will be recommend.
5) If the detailed assessment indicates aquatic habitats may experience sediment or runoff changes due to the project additional monitoring will be recommended. Monitoring will depend on site-specific conditions.
6) The lowest level of monitoring would entail completing a Rosgen Level II assessment at one reach downstream from the project area (or in an area potentially impacted by the project) and repeating measurements following a high flow/bankfull event or one year from the preconstruction survey. If impacts are indicated during the culverts and roads monitoring, repeating channel measurements may be recommended.
7) The next level of monitoring would entail establishing two Rosgen II stations. Data would be collected downstream from the project area and at one reference reach either upstream of the project area or from a reach having the same stream and valley type. Monitoring would consist of repeating measurements following a high flow/bankfull event or one year from the preconstruction survey and three years from the preconstruction survey.

8) The highest level of monitoring would entail multiple Rosgen II stations. Data would be collected at various locations throughout the project area and at a minimum of one reference reach either upstream of the project area or from a reach having the same stream and valley type. Monitoring would consist of repeating measurements following a high flow/bankfull event or one year from the preconstruction survey and three years from the preconstruction survey.
9) Complete the various intermediate and summary worksheets associated with the Level II work to allow interpretation of project level impacts compared to natural or existing conditions.
10) If monitoring shows that impacts are occurring, WGFD and the project developer will meet to discuss what corrective actions need to be taken to remedy the cause of the impact. If impacts are still occurring, additional monitoring maybe recommended.
11) Field techniques should follow the guidelines outlined in: Harrelson, C.C., C.L. Rawlins and J.P. Potyondy (1994); in Chapter 2 of Rosgen (2008); and in Chapter 5 of Rosgen (1996).
12) All data including GPS locations of cross section pins, upstream and downstream locations, photographs, survey data, pebble count data, etc. should be made available to the WGFD Staff Aquatic Biologist, Environmental Protection Program, within six months.

Storm Water Prevention Plan And Wyoming Construction General Permit
State and Federal laws require wind project developers to develop and submit a Storm Water Prevention Plan (SWPPP) to the Wyoming Department of Environmental Quality (WDEQ) that acts on behalf of the Environmental Protection Agency. The WGFD assumes each SWPPP will adequately address potential erosion issues and each project developer will institute permit stipulations to the best of their ability. However the SWPPP and Wyoming Construction General Permit may be modified to incorporate additional sediment and erosion monitoring. Such modifications could include WGFD monitoring recommendations. Please contact the Department of Environmental Quality for further information on modification of SWPPPs.

Any additional monitoring recommended by WGFD is meant to assist wind project developers and the Department in determining the presence, absence and/or extent of cumulative impacts resulting from changes to upland surface hydrology, erosion, deposition and the potential for impacting habitats important to fish, reptiles, and amphibians. The SWPPP required by the Construction General Permit addresses erosion and sedimentation control during active construction and the immediate post-construction period when revegetation is occurring. The WGFD aquatic recommendations look at the cumulative impacts on a given area of one or more projects over a much longer time frame. Under the Construction General Permit, as soon as vegetation at a construction site reaches 70% of typical background cover, storm water permit coverage is done. The Construction General Permit does not address or allow for monitoring long-term, non-point source pollution. If the Department is interested in long-term sedimentation and its potential for influencing aquatic wildlife, the Construction General Permit will not be helpful and other monitoring would be needed (WDEQ Memo, August 11, 2009).

Concerns have been expressed that channel and sediment monitoring under the WGFD aquatic recommendations duplicates Construction General Permit requirements. The monitoring required under the Construction General Permit only address the functionality of the erosion and sedimentation control best management practices at individual construction sites during the time of construction and revegetation. No downstream sampling for total suspended solids, turbidity or sediment accumulation is required. Theoretically, if all BMP's function well, are properly designed and installed and are well maintained, little or no sediment should leave a construction site. However, BMP's are only in place for a short time. Long-term monitoring addresses how the project, as designed, functions over time with respect to hydrology and sediment transport (WDEQ Memo, August 11, 2009).

Table 4: SGCN Fish Species (2005)

Bluehead Sucker	NSS1
Finescale Dace	NSS1
Flannelmouth Sucker	NSS1
Hornyhead Chub	NSS1
Leatherside Chub	NSS1
Pearl Dace	NSS1
Roundtail Chub	NSS1
Sturgeon Chub	NSS1
Suckermouth Minnow	NSS1
Western Silvery Minnow	NSS1
Bonneville Cutthroat Trout	NSS2
Burbot	NSS2
Colorado River Cutthroat Trout	NSS2
Goldeye	NSS2
Kendall WS Dace	NSS2
Orangethroat Darter	NSS2
Plains Topminnow	NSS2
Sauger	NSS2
Shovelnose Sturgeon	NSS2
Yellowstone Cutthroat Trout	NSS2
Black Bullhead	NSS3
Common Shiner	NSS3
Flathead Chub	NSS3
Lake Chub	NSS3
Mountain Sucker	NSS3
Plains Minnow	NSS3

RECLAMATION RECOMMENDATIONS

1. **Erosion Control:** Use best management practices to control erosion and prevent sediment from reaching nearby waterways.

2. **Topsoil:** Save topsoil removed for construction activities and spread over the disturbed area as soon as possible after disturbance to accelerate natural and artificial re-vegetation.

3. **Re-vegetation:** Prompt reclamation is essential as this can help minimize erosion issues and return lands to a useable condition for wildlife and livestock. We encourage private landowners to consider our reclamation recommendations on their property where it meets their operational management needs.

    a. Carefully plan for establishing a complex of vegetation that reflects the diversity of plant species and habitats in the surrounding area.
    b. Livestock grazing should be deferred until plants become established, which is typically two growing seasons.
    c. We recommend using only native grass/forb species palatable to wildlife.
    d. If hay or straw is used as mulch, it should be certified weed free.
    e. Monitoring reclamation for noxious and undesirable weeds should occur during and after construction with subsequent control as needed.
    f. Avoid planting monocultures.

4. **Accelerating Reclamation:** Reclamation may be accelerated by the use of locally derived cultivars and by mycorrhizal inoculations of shrubs and trees. In sagebrush habitat, prepare fire and weed control plans to protect both reclamation and adjacent sagebrush.

MITIGATION RECOMMENDATIONS

Current research is inadequate to determine the level of impact by wind energy development for most species of wildlife. A mitigation plan will be recommended outlining compensatory habitat conservation practices for offsetting wildlife losses in habitats defined as “vital” in the WGFC Mitigation Policy (focus management areas for SGCN species, big game crucial habitat, wetlands, and Blue Ribbon streams), if monitoring determines declines due to development in these habitats. Maps of these areas are available from WGFD.

APPENDIX C
ACRONYMS

APLIC ....Avian Powerline Interaction Committee
BACI ....*Before-After Control-Impact*
BLM ....Bureau of Land Management
BMPs ....Best Management Practices
DOE ....U.S. Department of Energy
DOI ....Department of the Interior
ESA ....Endangered Species Act
FAC ....Federal Advisory Committee on Wind
MWs..Megawatts
PLA ....Prediction Level Assessment
RLA ....The Reconnaissance Level Assessment
RRISSC... Rapid Resource Inventory for Sediment and Stability Consequence
SGCN ....Species of Greatest Conservation Need
SWPPP... Storm Water Prevention Plan
TAC ....Technical Advisory Committee
TMDL ....Total Maximum Daily Load
WARSSS………………………… Watershed Assessment of River Stability and Sediment Supply
WISC.. Wyoming Industrial Siting Council
WDEQ..Wyoming Department of Environmental Quality
WGFC...Wyoming Game and Fish Commission
WGFD ....Wyoming Game and Fish Department
WYBWG ....Wyoming Bat Working Group
WYNDD ....Wyoming Natural Diversity Database