North Dakota Chapter of the Wildlife Society
White Paper Describing the Issue of the Impacts of Wind Facilities on Wildlife

The North Dakota Chapter of The Wildlife Society (NDCTWS) is an affiliate of The Wildlife Society, which is an international, nonprofit, scientific and educational organization comprised of professionals, students, and laypersons active and interested in wildlife research, management, education, and administration. The NDCTWS favors the development of green energy sources, that is, those developments that use renewable energy sources while maintaining ecological sustainability in the physical locations where the developments are situated. Wind production in the United States is the fastest growing source of renewable energy, increasing from almost none in 1980 to 11,603 MW in 2006 (NRC 2007). Given that the U.S Dept. of Energy rates North Dakota as Number 1 in wind-energy potential among the top wind-producing states, the state is poised to become a leader in wind-energy production. Currently, North Dakota produces about 300 MW from over 200 turbines. Developers have publicly announced the additional proposed growth of about 1,300 MW from over 700 turbines, and there are other wind facilities planned for which announcements have not been made. Currently, about 8,000 MW of wind-generated electricity is being requested for interconnect status on the Midwest Independent System Operators electrical transmission queue (S. Wefald, North Dakota Public Service Commission, Bismarck, North Dakota, pers. comm.; Haley 2008). The 8,000 MW equates to 5,333 1.5-MW wind turbines. The amount of land in North Dakota under lease agreement with wind developers is unknown, although in South Dakota the figure is 300,000 to 500,000 acres (S. Wegman, South Dakota Public Utility Commission, Pierre, South Dakota, pers. comm.). Over 30 developers are actively seeking easements along practically the entire Missouri Coteau area (Haley 2008). The NDCTWS promotes a balanced approach to developing wind technology in the state, an approach that does not negatively impact native habitats and wildlife populations dependent on those habitats. Detrimental effects to habitats and wildlife populations affect North Dakotans' quality of life, traditional way of life, cultural heritage, and economic returns in the form of ecotourism and hunting.

STATEMENT OF CONCERN

The NDCTWS is concerned about the placement and operation of wind facilities in native prairie and the limited degree of state regulation of the industry. Poorly sited wind facilities have proven to have direct negative impacts on wildlife, mainly birds and bats, through strike mortality (NRC 2007). Poorly sited wind facilities placed in high-quality habitats (i.e., contiguous tracts of native habitat with high animal and plant species diversity and few to little invasive species) or in sensitive and rare habitats also have indirect negative impacts by altering habitat structure and integrity and displacing wildlife into less favorable areas (Kuvlesky et al. 2007). The NDCTWS promotes the advancement of regulations and programs that support wind energy while maintaining the integrity and functionality of native prairie and wetlands. To address these concerns, the NDCTWS advocates increased communication between wind developers, government regulators, and natural resource professionals at all stages of development, but especially in the planning stages. This white paper summarizes the current status of particular wildlife habitats and species in relation to the potential impact of wind development on them. The white paper also addresses the current state of knowledge regarding impacts of wind development on wildlife and measures taken in other states to reduce and minimize those impacts.

PRAIRIE IS A GLOBALLY IMPORTANT ECOSYSTEM

Prior to European settlement, the Great Plains was largely comprised of native prairie grasslands. The North American prairie is one the most imperiled habitats worldwide, with only approximately 30% remaining (Samson et al. 2004). One type of prairie, tallgrass prairie, is a globally endangered resource (Ricketts et al. 1999, Samson et al. 2004). North Dakotans have retained only about 28% of the original grasslands in the state (Strong et al. 2005), with a loss of nearly all of the tallgrass prairie and well over half of the mixed-grass prairie originally found in the state (Samson and Knopf 1994; Samson et al. 1998, 2004). Other states have lost between 30 to 99.9% of their native mixed-grass prairie. Much of the mixed-grass prairie that remains in North Dakota is found on the Missouri Coteau. Even that is threatened, however, as over 0.5 million acres have underwent conversion from 1982 to 1997 (USDA 2000). More recent estimates indicate losses of 125,000 acres in just five years, from 2002 to 2006, an amount that Nelson (2007) points out is equivalent to a one-mile wide strip from Bismarck to Fargo.

The loss of native habitats occurring in North Dakota mirrors trends nationwide. The past few decades have seen an accelerated transformation of the landscape as natural habitats are modified for human use (Trauger et al. 2003). The nation is experiencing a loss of biological diversity, and habitat loss and habitat alteration are the two leading threats to safeguarding the remaining biological diversity. Half of North America's most diverse ecoregions are now severely degraded (Ricketts et al. 1999). Most populations of native species have declined since the time of European settlement of the continent, some to the point of extinction, others to the point where their populations are threatened with extinction (Trauger et al. 2003). The two biomes at greatest risk of extensive habitat loss and under-protection are temperate grasslands and savannas; in these biomes, habitat conversion is more than eight times greater than habitat protection (Hoekstra et al. 2005). Intact native prairie harbors nearly 200 species of breeding birds, 71 mammal species, 11 amphibian species, and 15 reptile species (Strong et al. 2005), hundreds of plant species and thousands of insect species (NDPR 1999). Wetland density within native grasslands may be as high as 150 wetlands per square mile (Strong et al. 2005), which contribute to high biological diversity. Wetlands also serve as repositories for carbon, and can sequester over twice the organic carbon as no-till cropland (Euliss et al. 2006). Invertebrate, vertebrate, and plant species provide genetic diversity important to agriculture and medicine. Planted grasslands do not begin to match the diversity found in native prairie. In addition to its importance to wildlife, native prairie is also crucial for soil and water conservation.

The residents of North Dakota are fortunate in that the state still harbors some large expanses of open spaces; residents of other states have populated or converted their large areas of native habitats. Native prairie provides a reminder of our rural and pioneer heritage; it provides recreational activities such as hunting, hiking, and birdwatching; and it offers living laboratories for scientific research (NDPR 1999). Native prairie also provides economic benefits through such activities as livestock grazing, haying, native seed harvesting, and carbon sequestration. When we lose native prairie, we lose not only a valuable resource, but part of our natural heritage as well.

IMPACTS OF WIND DEVELOPMENT ON WILDLIFE

The concern over the effects of wind developments on native habitats and wildlife is mirrored across the nation. Because of the rapid expansion of wind developments throughout the U.S. and the highly publicized mortality events of birds and bats at some projects, this form of renewable energy has generated much national and international concern. Two overarching concerns are the degree of mortality to birds and bats and the degree of avoidance, or displacement, of animals due to the operation and infrastructure of wind facilities. In response to these concerns, the U.S. Congress requested the National Research Council (NRC), an arm of the National Academy of Sciences, to review the environmental impacts of wind-energy development, including effects on landscapes, viewscapes, wildlife, habitats, air pollution, and greenhouse gases (NRC 2007). Membership on the Committee on the Environmental Impacts of Wind Energy Projects comprised diverse areas of expertise, representing both public and private sectors, and natural and social science disciplines. The work of the Committee resulted in a report, *Environmental Impacts of Wind-Energy Projects*. The NRC recognized that the construction and operation of wind-energy facilities directly influence ecosystem structure. These influences include removal of vegetation, disturbance, compaction of soil, soil erosion, and changes in hydrologic features. Animals are impacted directly through mortality or indirectly through alteration of habitat and behavioral avoidance. The NRC recognizes that the numerous influences are likely cumulative, interact in complex ways, and interact with other anthropogenic disturbances.

Mortality

Bird and bat fatalities through collisions with wind turbines have been documented in Australia, Canada, Europe, and the United States (Arnett et al. 2007, NRC 2007). Of an estimated 1 billion birds killed annually as a result of collisions with human structures, between 20,000 – 37,000 birds died in 2003 from wind-energy structures (NRC 2007). Kuvlesky et al. (2007) reported the range of collisions as 0 to >30 bird collisions/turbine/year; this range includes figures from Europe and the United States. The impact of wind power facilities on wildlife varies by region and by species (GAO 2005). Wind-power facilities in northern California and in Pennsylvania and West Virginia have killed large numbers of birds and bats. Over 1,000 raptors have been killed each year by wind-power facilities in northern California, and over 2,000 bats were killed during a 1-year period in eastern West Virginia. Combined data from multiple, independent studies that included grassland or grassland-like habitat in the United States suggested the lowest rate of mortality was 2.3 birds/MW/year and the highest rate was 3.5 birds/MW/year (Strickland and Johnson 2007). Estimates of bat fatality from 20 studies at 18 different facilities ranged from 0 to 53.3 bats/MW/year (Arnett et al. 2007). Bat Conservation International has estimated that tens of thousands of bats would die annually if all the ridge-top turbines currently proposed for the Appalachian Mountains were actually constructed. However, because many facilities have not been studied, it is difficult to draw definitive conclusions about the threat that wind power poses to wildlife. Also, because much is still unknown about migratory bird and bat flyways and overall species population levels, it is difficult to determine cumulative impacts that the wind industry may have on wildlife species. It is also unknown what factors increase the chances that turbines will be hazardous to wildlife. Such factors may include the number, location, and type of turbine; number and type of species in an area; species behavior; topography; and weather.

Although at the current level of installed wind capacity, wind facilities may not have an impact on avian populations, the growth of the wind industry necessitates increased attention to tracking the factors that affect whole populations of some species. For bird species, the most common fatalities reported at wind-energy facilities belong to the order Passeriformes, the songbirds (NRC 2007). This group of birds is often the most abundant in terrestrial ecosystems. Based on 14 studies in which bird mortality at wind facilities was evaluated, passerines made up 75% of the fatalities at those facilities, followed by gamebirds at 11% and raptors at 6% (NRC 2007). In a review of avian collisions in 31 studies at wind facilities, Erickson et al. (2001) concluded that 78% of carcasses found at wind facilities outside of California were passerines, 4% of fatalities were gallinaceous birds, and 3% were raptors. Species' vulnerability to collision is most likely a function of abundance, local concentrations, and behavioral characteristics. The crucial issue is whether these deaths affect the populations of those species that suffer high mortality; lack of estimates of population sizes and population parameters makes it difficult to draw general conclusions about how wind turbines and population characteristics interact to influence mortality of both birds and bats. The NRC report stresses using systematic pre- and post-construction studies to explore potential impacts to wildlife and ways to improve how future facilities are built, located, and operated.

Habitat Loss and Fragmentation

Impacts from wind facilities on habitats include direct loss of habitat due to the actual footprint of the facility, including all related infrastructure, as well as indirect loss of habitat due to behavioral avoidance (displacement) of animals (Strickland and Johnson 2007). The construction and maintenance of facilities alters ecosystems through the clearing of vegetation, soil disruption, and the potential for erosion and noise. These changes lead to habitat loss and fragmentation for species. Temporary indirect impacts from construction of roads, turbine pads, etc. have been estimated at 0.4 to 2.6 acres per turbine (Strickland and Johnson 2007). Long-term impacts during facility operation are estimated at 0.7 to 1.0 acre per turbine. The Bureau of Land Management adopted a permanent footprint of 5-10% of the site in the Programmatic Environmental Impact Statement on wind energy development on public lands (BLM 2005).

Two effects of habitat fragmentation, habitat loss and the subsequent isolation of existing patches (Johnson 2001), are self-explanatory in terms of the habitat that is obviously lost and the patchwork pattern that remains. Less obvious is the loss of species that are area sensitive, meaning that they require large, contiguous grasslands to fulfill their biological needs and may either find the smaller and isolated patches insufficient and disappear from the area or they may suffer low reproductive success. Research has shown that several species of grassland birds, including game species such as Greater Prairie-Chickens, are indeed sensitive to a reduction in grassland acreage. Many of these species are listed in North Dakota's Wildlife Action Plan as being in need of conservation action (Hagen et al. 2005). The third effect of habitat fragmentation is that of increased edge habitat (Johnson 2001). Edge refers to that interface between two different habitat types, e.g., between grassland and woodland. Habitat fragmentation increases the amount of edge habitat within fragments. Studies have found that brood parasites as well as predators of eggs, young, and even adults of grassland birds may be more abundant and active in edge habitats than in interior grasslands, thus lowering grassland bird productivity.

Very few studies have examined the displacement impact of wind facilities on birds (Strickland and Johnson 2007, Mabey and Paul 2007), but see reviews by Hay (2006), Arnett et al. (2007), and Mabey and Paul (2007). Disturbance of wildlife at wind farms may occur due to increased human presence associated with facility construction and maintenance or the presence and noise of the turbines (Hay 2006). Estimated indirect impacts appear to be relatively small, and the magnitude of displacement is uncertain, ranging from near zero to several hundred meters (Strickland and Johnson 2007). The reported zone of influence for some species in which a reduction in bird use has been reported is as much as 600 m away from turbines; however, effects of disturbance likely vary by species, season, and site (Langston and Pullan 2003 *in* Hay 2006). Siting at both the macro level (location of wind facilities) and at the micro level (turbine and turbine string location within the site) is believed to be the best way to minimize impacts.

Roads and Invasive Species

The construction of wind developments includes the construction of roads, some in previously roadless areas. Roads allow vehicular access to remote grasslands, thus increasing habitat fragmentation (Saunders et al. 2002). Roads have detrimental impacts on wildlife and wildlife habitats through various ways, including causing loss of biodiversity, creating avenues for the spread of invasive plants and creating optimal growing sites for those plants, serving as barriers for animal dispersal and thus genetically isolating populations, enhancing movements of predators, and causing mortality through collisions (Kuvlesky et al. 2007). Trombulak and Frissell (2000) demonstrated the negative effects of roads on the biotic integrity of an ecosystem. For example, roads cause animal mortality from road construction and from collision, modification of animal behavior, alteration of the physical environment, alteration of the chemical environment, increased spread of invasive plant species, and increased use by humans. Roads also have the potential to affect hydrology in that wetlands separated by roads or near roads can lose their biological integrity and ecological functions. In examining causes of endangerment for North American species classified as threatened or endangered by the U.S. Fish and Wildlife Service, Czech et al. (2000) concluded that roads were associated with more other causes of species endangerment than any other cause. Increased and easier access for farm machinery may accelerate the conversion of grassland to cropland as well as increase avenues for the spread of invasive plants.

Roads serve as a means for humans and their associated companion animals and vehicles to introduce non-native, invasive species into areas that formerly were free of invasive plants. Unfragmented native prairies often contain relatively pristine areas. Nationwide, 45% of plants considered “weeds” in pastures are non-native species (Pimental 1993, Pimental et al. 2005). About $10 billion in forage crops is produced annually on U.S. pastures (USDA 1998); the estimated losses due to undesirable plant species are approximately $2 billion (Pimental 1991). The forage losses due to undesirable non-native plant species are nearly $1 billion annually (Pimental 1993). Some introduced plant species also are toxic to cattle and wild ungulates, such as leafy spurge (*Euphoria esula*) (Trammel and Butler 1995). Several non-native thistles have replaced desirable native plant species in pastures, rangelands, and forests, thus reducing forage for grazing cattle. Ranchers spend about $5 billion annually to control invasive plant species in pastures and rangelands (Babbitt 1998). Losses to cropland and rangeland productivity exceed $7 billion. Undesirable plant species infest 100 million acres in the U.S. and spread at a rate of 14% per year (Babbitt 1998).

Electrical transmission lines

Large wind facilities will require the construction of electrical transmission lines. Transmission lines create risks for wildlife, particularly birds, in the form of electrocution and collision (Kuvlesky et al. 2007). Erickson et al. (2001) conservatively estimate that ≥174 million bird fatalities occur every year in the United States from power line collisions.

Cumulative impacts

Many plant and animal species are sensitive to anthropogenic disturbance, be it increased human presence on the landscape or the introduction of a non-native plant into the environment. These types of influences seldom work independently on an organism. The combination of new roads, more vehicular traffic, increased human presence, alteration of wetlands, introduction of non-native plants, the building of a very large structure on the landscape (i.e., the wind turbines themselves), and other anthropogenic disturbances, are termed cumulative impacts. The cumulative impacts of wind developments and other anthropogenic pressures on wildlife are unknown and are very difficult to study. One point to keep in mind is that where one wind facility may have no discernible negative influence on organisms, the accumulation of numerous wind facilities built in the same area may begin to break down species' thresholds of tolerance to disturbances.

Many states have cutoffs for project size or turbine size, below which regulatory scrutiny either is not required or is much reduced (NRC 2007). If several small projects are installed in a small area, their effects could accumulate without the benefit of regulatory review.

WIND INDUSTRY CONTRIBUTION TO ENERGY SUPPLY

The 11,603 MW of energy produced by wind facilities in the United States in 2006 represented less than 1% of U.S. electricity generation in that year. Projections of onshore wind-energy developments in the next 15 years ranges from 19 to 72 gigawatts, or 2 to 7% of projected U.S. onshore installed electricity-generation capacity (NRC 2007). This equates to 3.5 to 19% of an increase in total electricity-generation capacity and would require 9,500 to 36,000 2-MW wind turbines. The highest forecast for 2020 indicates that wind-energy development will provide 7% of total installed electricity-generation capacity and 4.5% of electricity generation, given that wind turbines generally have lower capacity factors than other electricity-generation sources. It is unlikely that wind production will replace fossil fuels (Arnett et al. 2007). Whereas wind may contribute to the production of electricity, higher public demand will be such that the proportion of that demand met by wind will not change. Ausubel (2007) examined the contributions of various energy sources and concluded that renewable sources of energy are "green" only in small increments. At a large scale, such as that needed to fuel the world's current demand of 10 million MW, renewable sources of energy would require large land masses. For example, a 162-MW wind farm comprised of 1.5-MW wind turbines requires about 4800 ha (11,861 ac), or 29.6 ha/MW (73 ac/MW). Running at the typical 30% capacity, peak power density is 1.2 watts/m^2. To meet the U.S. electricity demand in 2005 of 4 million MWhr, a wind facility would need to cover 780,000 km^2 (301,160 mi^2). Some groups suggest that energy conservation could easily make up wind's small potential contribution (NWW 2007).

Many states have enacted or are developing Renewable Portfolio Standards (RPS), which set numerical targets requiring utilities to increase reliance on solar radiation, wind, water, and other renewable sources of energy for electrical generation (Arnett et al. 2007). These standards create powerful mandates for utilities to develop renewable energy sources. However, RPS pay little attention to the negative environmental impacts that may accrue from a burgeoning wind industry in a particular state or region.

ECONOMICS

The National Research Council assessed the potential positive and negative economic and fiscal impacts of wind developments (NRC 2007). Studies were inconclusive regarding the effect of wind development on property values, ranging from no impact to an uncertain impact. To the extent that a property is valuable for the potential to experience life in a remote and relatively untouched area, a view of many turbines may detract from property values. Although the authors of the NRC report failed to reach definite conclusions concerning the impact of wind-energy developments on property values, they did identify factors that should be considered. These include opposition that may result from having views and sightlines altered. Shadow flicker caused by moving blades has been a nuisance issue raised in some areas. Aesthetic impacts come into play when a project is sited in remote and relatively untouched areas. The experience of certain historic or sacred sites or landscapes can be indirectly affected by wind developments, especially if the surrounding landscape is important to the experience, interpretation, and significance of the proximate historic or sacred site.

The Government Accountability Office (GAO) examined the contribution of wind developments to farmers' income and rural communities (GAO 2004). In the 10 states with the highest installed wind capacity, wind power did not contribute significantly to total farm income, although wind power did benefit some individual farmers and rural communities. A farmer who leases land for a wind project can expect to receive $2,000 to $5,000 per turbine annually in lease payments. The GAO (2004) found that owning projects would be more profitable to landowners than leasing, but landowners generally found leasing to be an easier and more obtainable option because most farmers cannot qualify for the federal production tax credit. In Minnesota, farmers have entered equity partnerships with other investors to benefit from the federal production tax credit. Under equity partnerships, investors own a majority interest for the first 10 years, receiving most of the income. After the 10-year period, the majority ownership is transferred to the farmers. One example of this is the Kas Farm project in Pipestone County, Minnesota. Also in Minnesota, farmers have formed limited liability companies to make use of the production tax credit. These companies developed the Minwind I and II projects in Rock County, Minnesota (GAO 2004).

Large wind power developments in rural communities contribute to tax revenues and employment opportunities (GAO 2004). For example, in Lincoln County, Minnesota, where the human population was 6,200 in 2003, 18% of that year's property tax revenues, or $470,000, came from a wind facility with a capacity of 156 MW. The GAO asked the National Renewable Energy Laboratory (NREL) to use its Wind Impact Model to estimate the benefits for several counties with wind facilities. NREL modeled the differences between a 40 MW project and a 150 MW project, both owned by out-of-area companies, vs. 20 locally owned projects, each with a 2-MW capacity. Models were run for both construction and operation periods. In general, counties with a larger, more diversified economic base retained more of a project's direct economic benefits than counties in which services and supplies had to be obtained from outside the county (GAO 2004). Economic impacts were considerably greater for projects that were locally owned than for projects that were owned by out-of-area wind developers.

Wind developments are recognized as sources of jobs. One MW of installed wind capacity directly and indirectly creates about 60 person-years of employment and 15-19 jobs, but the rate of job creation will diminish as the industry grows and takes advantages of the economies of scale (AWEA 2006). However, there may be adverse impacts in that while a few turbines may be a tourist attraction, a proliferation may have the reverse effect. Also, whereas some local jobs may be created, some other sectors of economic growth, such as recreational opportunities and related amenities, might decline. And so, whereas a wind-energy development may generate tax dollars for the local government, one form of economic development must be balanced against that particular form of development deterring other forms. A wind-energy facility also may incur public costs. Improvements to public roads, for example, may be expected, whereas improved community services in the wake of development may be significant, but not foreseen. NRC (2007) recommends the JEDI (Jobs and Economic Development Impacts) economic model, developed for the National Renewable Energy Laboratory, be used to estimate the economic benefits of a new wind-energy facility. The National Wind Coordinating Collaborative (NWCC) also provides guidelines for assessing the economic development impacts of new facilities (NWCC 2001). NWCC (www.nationalwind.org) is a consensus-based collaborative funded through the Department of Energy that identifies issues that affect the use of wind power, establishes dialogue among key stakeholders, and catalyzes appropriate activities to support the development of environmentally, economically, and politically sustainable commercial markets for wind power. NWCC members include representatives from electric utilities, state legislatures, state utility commissions, consumer advocacy offices, wind developers, green power marketers, environmental organizations, agriculture and economic development organizations, and state and federal agencies.

For North Dakotans at a local level, there will likely be financial gains to the school district, county, and state, as well as benefits to local manufacturers of such parts as blades. FPL Energy's 41-turbine wind facility in LaMoure County contributes annual tax revenues of $100,000 to the county, $170,000 to the Kulm school district, and $30,000 (or ¾ of 1% of energy produced) to the local economic development corporation (F. Evert, Tax Equalization Director, and M. Johnson, Auditor, LaMoure County, pers. comm.). The township also could levy taxes (estimated at $18,000) but currently is not doing so. However, it is difficult for the public to assess the gains to government and private business vs. the potential loss to other businesses or to quality-of-life issues. As an example, oil development in western North Dakota is placing burden's on the region's roads and water supply (Jamestown Sun 2007). It would be a worthwhile endeavor to commission a study to identify and examine the costs and benefits of wind developments at both the local and state level for North Dakota, similar to the studies conducted by Bangsund and Leistritz (2003), Burke-Olson (2007), Coyle (1998), and Hodur et al. (2004). These authors conducted analyses that investigated the economic impacts to North Dakota of nature-based tourism, including that of hunting, fishing, and non-consumptive pastimes, such as birdwatching.

It is difficult to assign an economic value to wildlife, so often the economic amenities associated with wildlife (e.g., hunting license revenues, hunting equipment) are used as relative values (Trauger et al. 2003). Conflicting societal values toward wildlife exist; for example, some individuals believe natural resources exist or have value only for human consumption, whereas others believe natural resources are held in public trust for their intrinsic values that are higher than values as economic commodities. Regardless, societal values can have profound effects on an industry if the perception of an industry is that it is detrimental to wildlife and the environment in general.

Impact of Prairie Loss to North Dakota

The value of grasslands free of human and vehicular disturbance is often underestimated and undervalued. Vast acreages of undisturbed native habitats are highly sought after by humans seeking to escape the pressures of an increasingly populated and technological world. Consider the fact that humans can get no further than 22 miles from a road in the conterminous United States (Watts et al. 2007), and the wide open spaces afforded by North Dakota should not be undervalued. Even so, 99% of North Dakota's land area is within 2 miles of a road; the maximum distance from a road is 3 mi. (Strong et al. 2005). Those areas within the state that remain relatively unfragmented will take on higher value by humans as the nation's population increases from around 281 million in 2000 to an estimated 400 million by 2050 (U.S. Census Bureau 2000, 2004). Total urban area has more than doubled over the last 40 years from 25.5 million acres in 1960 to 55.9 million acres in 1990 (Trauger et al. 2003).

The possibility of the construction of wind facilities in relatively pristine and unfragmented habitats brings up societal questions regarding economic growth and natural resource use and allocation (Trauger et al. 2003). There are competing views on the value of wildlife and habitats upon which they depend versus economic development and growth. One benefit of maintaining the contiguous nature of the state's grasslands is the economic benefits that North Dakotans derive from maintaining open spaces that harbor abundant populations of wildlife. These grasslands are "working" landscapes not only in the sense that they are prime ranchland, but they also are a hunter's and wildlife watcher's mecca. One reason North Dakota is so popular for hunters and birdwatchers is that the state still harbors large expanses of open spaces that offer respite from human presence; residents of other states have populated or converted their large areas of native habitats, as explained above. The opportunities that wildlife offers to hunters alone represent an economic contribution to North Dakota of $365 million in gross business volume, not including license sales (Bangsund and Leistritz 2003). According to the Department of Commerce, Tourism Division, tourism is the second largest industry in North Dakota (Burke-Olson 2007).

The Wind Resource Map for North Dakota created by the National Renewable Energy Laboratory indicates that the highest potential for wind energy-production is along the Missouri Coteau (www.eere.energy.gov). The Missouri Coteau is the high ridge that runs through central North Dakota and South Dakota east of the Missouri River. It was formed by glacial action thousands of years ago. Hilly topography and rocky soils historically made much of the Missouri Coteau unsuitable for conversion to cropland. Therefore, the Coteau contains large, contiguous tracts of native mixed-grass prairie and undrained wetlands. Thus, because of the contiguous nature of the Coteau grasslands, this formation represents some of the last remaining areas in the state of a functioning, intact prairie ecosystem. Accordingly, the Coteau is a prime area for nesting waterfowl and other grassland birds, many of which have suffered marked population declines in recent decades due largely to habitat loss. Models prepared by the Habitat and Population Evaluation Team of the U.S. Fish and Wildlife Service in Bismarck indicate that the areas along the Coteau that hold the greatest potential for production of grassland-nesting birds in North Dakota often overlap with the areas of highest wind potential (Reynolds et al. 2006). This is one important area of North Dakota that merits closer attention to siting of wind farms for their potential to have negative impacts on North Dakota wildlife.

Kuvlesky et al. (2007) makes a convincing argument for locating wind facilities on cropland. Although their arguments were developed for the Lower Gulf Coast of Texas, some arguments are applicable to North Dakota. Those arguments are that abundant cropland exists in areas windy enough to drive turbines, farming cropland can be a risky business largely sustained by crop insurance or subsidy payments and that wind development can create a drought-proof form of income, native vegetation has already been removed from cropland and so cropland may be less attractive to wildlife, and cropland landscapes already contain a network of roads.

REGULATORY RESPONSIBILITY

In the United States, wind energy regulation is primarily the responsibility of state and local governments (GAO 2005, NRC 2007), primarily because most development is occurring on private land (Arnett et al. 2007). Both the Government Accountability Office (2005) and the National Research Council (2007) concluded that regulatory agency officials often lack the experience or expertise to anticipate, review, and assess the impacts of wind facilities on the environment. The solution of officials of Alameda County, California, was to use technical consultants during the permitting stage and to form a Technical Advisory Committee for post approval monitoring. In Minnesota, most wind development is concentrated in one part of the state. For efficiency, the state conducted one large-scale study of environmental impacts rather than requiring each developer to conduct individual studies. Wind developers participated in a 4-year avian impact study and a 2-year bat study. The California Energy Commission and the California Department of Fish and Game recently developed science-based guidelines to be used by counties, cities, and public utilities that issue permits for wind-energy projects (Anderson et al. 2006). The guidelines address means to reduce the impacts to birds and bats, including uniform methods for such areas as studying bird and bat movements, pre- and post-construction monitoring plans, and developing avoidance, minimization, and mitigation measures. The consistent application of these methods by the various agencies and wind developers will allow for analyses of trends and patterns of impacts and multiple sites, thus improving the ability to predict and resolve impacts locally and regionally. Guidelines are offered for subjects such as preliminary site screening to evaluate sensitivity of sites to birds and bats; impact avoidance, minimization, and mitigation; and the establishment of Science Advisory Committees as sources of advice on the many aspects of permitting processes.

Impact Avoidance, Mitigation, and Decommissioning

Concomitant with the increase in wind development in the United States are increased policies and guidelines enacted at all levels of government that are designed to minimize the effects of wind power development on wildlife. The NWCC created a "mitigation toolbox" to provide direction for future wind-development projects by presenting an assortment of mitigation measures that can be used to minimize or eliminate the negative impacts to wildlife that result from the design, construction, and operation of wind farms (NWCC 2007). It includes a compilation of mitigation policies, guidelines, and research that are either directly or indirectly applicable to the wind industry. The definition of mitigation used in the toolbox is the same as that established by the U.S. Fish and Wildlife Service (USFWS 1993):

"The President's Council on Environmental Quality defined the term "mitigation" in the National Environmental Policy Act regulations to include:
'(a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation;

(c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; (e) compensating for the impact by replacing or providing substitute resources or environments.' [40 CFR Part 1508.20(a-e)]."

California's guidelines provide an example of one state's policies regarding impact avoidance, mitigation, and decommissioning (Anderson et al. 2006). That state, as do others (NWCC 2007), stresses the importance of site selection and screening. Careful site selection helps ensure no or minimal impacts. Careful siting of the turbines and related infrastructure helps avoid or reduce potential impacts to wildlife (Anderson et al. 2006). Careful siting includes such strategies as avoiding large, contiguous areas of undisturbed wildlife habitat; avoiding wildlife corridors used daily, seasonally, or year-round; placing power lines underground; ensuring compliance of above-ground power lines with standards devised by the Avian Power Line Interaction Committee (APLIC 2006); and avoiding guyed wires.

Where impacts do occur, compensation is a common way to mitigate or offset impacts (Anderson et al. 2007). Compensation typically involves the purchase of land through fee title or purchase of conservation easements or other land conveyances and the permanent protection of the biological resources on these lands.

Many states recommend that non-operational wind turbines be decommissioned. According to Anderson et al. (2007), decommissioning involves the removal of turbine foundations to 1 m (3 ft.) below ground level and removing access roads and unnecessary fencing and ancillary structures. The California state guidelines suggest that developers submit a decommissioning and reclamation plan that describes expected actions when some or all of a wind-energy project is non-operational (Anderson et al. 2007). The plan should discuss in detail how wind turbines and associated structures will be dismantled and removed. The plan also should include documentation showing the financial capability to carry out the decommissioning and restoration requirements, usually an escrow amount, surety bond, or insurance policy in an amount sufficient to remove the wind turbines and restore the site.

Guiding Principles

One of the main findings of the NRC was that regulatory systems and planning processes have not kept pace with the rapid growth of the industry (NRC 2007). Most wind facilities are approved through local zoning boards and state authorities. State and federal agencies lack the experience to anticipate, review, and assess the impacts of wind facilities on the environment. The report urges state and federal agencies to take the environmental impacts of wind energy more seriously, in order to better carry out mandates to protect species and to weigh tradeoffs between the technology's environmental benefits and impacts. To aid in evaluating wind–energy projects, the NRC report created a guide for agencies involved in weighing the pros and cons of proposed wind projects. That guide addresses key elements, including but not limited to the following:

- Early notification by wind developers to interested and affected parties, as well as the general public
- Availability of guidance to developers, regulators, and the public concerning adverse and beneficial effects of proposed wind-energy developments, including involving the public and locally affected inhabitants in evaluating potential adverse impacts

- Determining whether procedures are in place for evaluating impacts of wind-energy projects that cross jurisdictional boundaries
- Determining whether steps are in place that explicitly address the cumulative impacts of wind-energy projects over space and time, i.e., reviewing each new project in the context of other existing and planned projects in the region. The consideration of cumulative effects may include all other anthropogenic impacts in the area
- Determining whether the biological, aesthetic, cultural, and socioeconomic attributes of the region are sufficiently well known to allow an accurate assessment of the environmental impacts of the wind-energy project. Are there key species, habitats, recreational sites, or cultural sites of special interest or concern? Has expert consideration been employed?
- Determining whether pre- and post-construction studies are needed, who will conduct them, and what environmental mitigation measures will be taken

Lacking at a national level is an oversight agency or commission to review and regulate wind energy development on private lands; such a body would help streamline regulations among local, state, and federal governing bodies (Arnett et al. 2007). Some state fish and wildlife agencies have issued regulatory guidance. For example, the state of Washington has issued guidelines that provide siting principles and mitigation policies and guidelines (http://wdfw.wa.gov/hab/engineer/windpower/wind_power_guidelines.pdf). The guidelines stress placing wind facilities on disturbed lands. Where wind facilities are built on native habitats, mitigation is required. For high-quality habitats, such as native shrub-steppe, replacement habitat must be acquired at a 2:1 ratio. The NWCC recently compiled a document that summarizes guidelines from about 12 states, 4 federal agencies, 3 foreign countries, and non-governmental organizations (NWCC 2007). Furthermore, a sample of the approaches to siting that various states, municipalities, and other jurisdictional entities have taken was compiled by the NWCC and the National Conference of State Legislatures. That compilation, *State Siting and Permitting of Wind Energy Facilities*, is available at http://www.nationalwind.org/publications/siting/Siting_Factsheets.pdf. The NWCC has further provided a handbook, *Permitting of Wind Energy Facilities*, available at http://www.nationalwind.org/publications/siting/permitting2002.pdf.

With the exception of federal trust species, wildlife conservation lies within the jurisdictional authority of state fish and wildlife agencies (GAO 2005, Arnett et al. 2007). Federal jurisdiction is limited to sites on federally owned lands or where federal funding or permits are involved. Federal laws that pertain to wind-energy development are the Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, Endangered Species Act, and the National Environmental Policy Act.

Where federal jurisdiction does not prevail, and even where it does, North Dakota policymakers should begin to engage state, federal, and tribal agencies, non-governmental organizations, and the citizens, to create policies that encourage the siting of wind facilities in areas that do not cause harm to the wildlife and wildlife habitats that make North Dakota a special place. North Dakota is one of those rare states that still contains wide open spaces that affords humanity a refuge from the hustle and flow of life. However, as stated above, those assets may be at odds with the development of industrial wind facilities. Because tourism is so pivotal to North Dakota, including ecotourism and hunting and fishing opportunities, it behooves the state to enact responsible policies that find common ground between economic development and a sound, intact natural resource base.

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