Phase I Avian Risk Assessment for the Lempster Mountain Wind Power Project Lempster (Sullivan County) New Hampshire

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Report Prepared for:

CEI New Hampshire Wind, LLC

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Executive Summary

This report details a Phase I Avian Risk Assessment for the proposed Lempster Mountain Wind Power Project (hereafter the "Project") in the township of Lempster, Sullivan County, New Hampshire. It includes a review of the literature and available databases, a site visit (September 13-15, 2004), and a written consultation with the U.S. Fish and Wildlife Service (New England Field Office) and the New Fish and Game Department. The literature and database review examines both the impacts to birds at wind power facilities and the avifauna that may be present at the site or in the general area. The site visit focused on evaluating habitat to determine the type and number of birds likely to nest, forage, rest, or use the project site. Together, the information gathered provided an indication of the type and number of birds that are known or suspected to use the Project. This information was then incorporated into a risk assessment to determine the degree of risk to birds from the proposed wind power development.

The Lempster Mountain Wind Power Project would be a small to moderately sized wind plant that would consist of between about 12 and 20 wind turbine generators, totaling about 24 to 30 megawatts of nameplate capacity. Tower height would likely be about 80 meter (262 feet), with rotor lengths up to about 42 m (138 feet). Maximum height of the rotor tip when the rotor is in the 12 o'clock position could be up to about 122 m (400 feet) AGL. Each turbine would nameplate generation capacity of about 1.65 to 2.0 megawatts. The Project is being proposed by CEI New Hampshire Wind, LLC.

Turbines would be situated on the highest portions of Lempster Mountain, from Silver Mountain in the south to Kennedy Hill in the north. Elevations where turbines would be located range from about 1,850 feet to 2,240 feet (564-683 m) ASL. The mountain is a series of hills oriented from north-northeast to south-southwest. The site is mostly northern forest, with some boreal elements. Trees are a mixture of deciduous hardwoods mixed with some conifer, with fairly large patches of red spruce. The tops of hills are either, mixed hardwood and conifer, continuous red spruce, or balds, and there are clearings here and there throughout the site. Some fields were evident, usually adjacent to residences. Land use is primarily forestry (small logging operations) and recreational. There is a road that extends through the prospective turbine area, several residences on Lempster Mountain, and there are communication towers on the mountain.

The Project site and adjacent habitats support a diverse assemblage of common and less common nesting species of forest edge, brushland, and forest interior. The habitat is not suitable for nesting by any federally or state listed (endangered and threatened) species. A letter from New Hampshire Fish and Game stated that their records indicated "no known locations of state listed species found within the boundary of the project" but the turbines could have impacts on

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migratory birds. A letter from the U.S. Fish & Wildlife Service reinforced the statements of the state agency in that they reported no federally-listed species or species proposed for listing at or near the project site. The letter did suggest that migrating Bald Eagles (threatened) could be present at times. The site and area surrounding the site does not appear to be suitable for nesting by eagles, although ponds within 1-2 miles (1.6-3.2 km) from the Project site might attract these birds at times.

There are likely to be small numbers of migrating hawks that soar along the sides of Lempster Mountain, although the numbers present are unlikely to indicate a significant migration pathway. With respect to other waterfowl, waterbirds, shorebirds, and songbirds, there is no reason to suspect that a significant migration pathway or corridor occurs in the area and migration is likely to be broad front. Although the site is not suitable for stopovers by large numbers of waterbirds, waterfowl and shorebirds during migration, modest numbers of night migrating birds are likely to make stopovers on site. The diversity and numbers of birds present on site in winter is likely to be minimal because of the harsh conditions and lack of forage or open water on site.

The following recommendations are made:

- Electrical lines within the project site should be underground between the turbines and any new above ground lines from the site and substations to transmission lines, should follow APLIC (Avian Power Line Interaction Committee) guidelines to reduce the potential for electrocution.

- Permanent meteorology towers should be free-standing and unguyed to minimize the potential for avian collisions.

- Size of roads and turbine pads should be minimal to disturb as little habitat as possible. After construction, forested habitat should be permitted to regenerate as close to turbines and roads as possible to minimize habitat fragmentation and displacement impacts to nesting birds.

- Lighting of turbines and other infrastructure (turbines, substations, buildings) should be minimal to reduce the potential for attracting night migrating songbirds and similar species. FAA lighting for night use, if needed, should be red or white flashing, strobe-like or strobe lights with the longest off cycle permissible. No steady burning FAA lights should be used and sodium vapor lamps, spotlights, and other lights should not be used onsite at night except for emergency maintenance or personnel safety.

- Because the forests on site appear to be suitable for forest interior species that are sensitive to fragmentation, pre- and post-construction breeding bird studies should be done to determine the degree of displacement of nesting birds, the impacts of forest fragmentation to these birds, and whether or not interior forest nesting birds habituate to the presence of wind turbines. An impact gradient study design is recommended. That research design should be peer reviewed or reviewed by the state or federal wildlife agency to insure it is robust and will measure impacts accurately.

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- A post-construction study of collision fatalities would be helpful to future wind power development in New England and New Hampshire, where there is only one utility-scale wind power facility currently operating. Such a study would provide information on the number and type of fatalities that occur, and determine the biological significance of the fatalities documented.

Collision risk to birds at the Lempster Mountain Wind Power Project is likely to be minimal and not biologically significant. With respect to interior forest nesting songbirds, clearing of forest in some places is likely to cause habitat disturbance and displacement of some species, in addition to fragmentation. Such impacts are poorly studied, so the level of impact to sensitive thrushes, warblers, and other neotropical songbirds cannot be determined, nor do we know if these birds will habituate to the presence of turbines. Although migration over the site is not likely to be concentrated in numbers that suggest high risk, the U.S. Fish and Wildlife Service may request radar or other remote sensing studies prior to construction of the Project.

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Introduction

Although wind power is considered to be one of the most environmentally benign sources of electrical power, birds and bats have been impacted at projects in the United States and Europe. Because of these impacts, concern has been raised regarding newly proposed wind power projects. Impacts to birds have included collisions with turbine rotors and meteorology towers, and disturbance/displacement of nesting and feeding birds resulting from construction activities and new infrastructure.

A small to moderately sized wind power plant is proposed for a site near the town of Lempster in Sullivan County, New Hampshire (Figure 1). The project has been named the Lempster Mountain Wind Power Project (hereafter referred to as the "Project." This report details a Phase I avian risk assessment conducted for that Project. The purpose of a Phase I risk assessment is to determine the potential for risk to birds at a proposed project site. Thus, the Phase I assessment is designed to guide developers, regulators, environmentalists, and other stakeholders through the risk assessment process at a particular site, including how potential impacts may require further study. This assessment includes: (i) a site visit, (ii) a literature/database search, and (iii) consultation with wildlife agency biologists. In addition, Appendix I of this risk assessment report addresses compliance issues and recommendations now being made by the U.S. Fish and Wildlife Service via their "interim" and "voluntary" guidance for wind power projects (U.S. Fish and Wildlife Service 2003).

A site visit was undertaken by an avian technician with experience in bird identification and habitat evaluation. That person is also highly experienced in evaluating avian habitat, with respect to what species are likely to be present. The site was walked and the area surrounding the site toured by automobile. The purpose of the site visit is to evaluate habitat and topographic features so that a list of species that might be present may be assembled and the potential for risk to those birds assessed. The site visit is not meant to be an exhaustive inventory of species presence and use.

Avian literature and databases examined came from the U.S. Fish and Wildlife Service, New Hampshire Fish and Game Department, Audubon Christmas Bird Counts, hawk migration literature/newsletters (Hawk Migration Association of North America), USGS Breeding Bird Surveys, the Important Bird Areas program, and other information on birds that might nest, migrate, forage, winter, or concentrate at the site. A second part of the literature search focuses on the issue of wind turbine impacts to birds and what is know about those impacts.

Consultations were done with wildlife agency biologists, including U.S. Fish and Wildlife Service and New Hampshire Fish and Game Department, via a letter requesting information on listed species at or near the Project site. In addition, telephone calls were made to those agencies to request a conf call or meeting to provide information to the agencies regarding the specific project and the impacts of wind turbines on birds, as well as specific agency concerns. More specifically, the consultations are an effort to determine more about the avifauna at a site and potential risk to birds that are likely to be present. Such consultation and meetings

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are a means of determining the scope of work that may be needed to further assess risk after the Phase I has been completed.

The information from databases, literature searches, the site visit, and consultations with wildlife agency biologists were then integrated into this report summarizing habitat and birds likely to be present at the site, potential risk of wind turbines at the site, a comparison the project site with other sites where risk has been determined, and recommendations for further studies and, or mitigation.

Project Description.

The Lempster Mountain Wind Power Project would consist of about between 12 and 20 wind turbine generators, which, depending on the specific equipment chosen, would each have a nameplate capacity of between 1.65 and 2.0 megawatts. Together they would produce a total of about 24 to 30 megawatts of generating capacity. The Project is east of the town of Lempster (Figure 1). Tower heights would likely be about 80 meters (262 feet) with rotor lengths of between about 42 m (131-147 feet). Maximum height of the rotor tip when the rotor is in the 12 o'clock position could be up to about 120-125 m (394-410 feet) AGL. Turbines would mount on steel tubular towers and all or a subset of them would be lit according to Federal Aviation Administration guidelines. As with most new turbine installations, lighting would probably be red strobes (L-864) on the nacelle at about 82 m (269 foot) AGL. Most electrical collection lines within the project area would be underground. A substation would be constructed on site from which a transmission interconnect would be made. That interconnect could be above ground, connecting with existing transmission lines near the site.

Topographic/Physiographic and Habitat Description of the Lempster Mountain Wind Power Project Site

Information regarding topography, physiography, and habitat of the site was first gathered using a 1:24,000 USGS topographic map, and later from ground truthing via a site visit during late summer/early fall 2004. In addition, several texts were examined to determine the type of habitat known to be present in the general vicinity of the proposed wind plant and, therefore, the bird communities and species that are likely to be present (Foss 1994, Hodgman and Rosenberg 2000).

Lempster Mountain is within the New England physiographic province (Hodgman and Rosenberg 2000), which, in New Hampshire, is south of the White Mountains, but within an area of smaller mountains and hills that extend over much of southern New Hampshire (Figure 1). The Project site is within the Physiographic Area 27 designated by Partners In Flight, also called the Northern New England physiographic region (Hodgman and Rosenberg 2000). This region consists of lower elevation mountains, few of which extend to more than about 2,500 feet (762 m) ASL and most of which extend to about 1,500-2,200 feet (457-671 m) ASL, near the Project site. The Northern New England physiographic region consists of a variety of hardwood and mixed forests (hardwood and conifer) that vary depending upon elevation and aspect. There are also elements of the Partners In Flight Physiographic Area 28 within the Project boundaries.

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This physiographic region is called the Eastern Spruce-Hardwood Forest, which is mostly to the north of central New Hampshire. The higher elevations of south central New Hampshire are covered with spruce and some balsam fir, which makes them very similar to the spruce-hardwood forests to the north, and makes them suitable for many of the bird species that inhabit those forests.

Foss (1994) refers to part of the New England Physiographic Region region in western and into northern New Hampshire as the Highlands Physiographic Region. The Lempster Mountain site is in the Western Highlands Physiographic Region of this larger region.

The Lempster project is situated along a northeast to southwest oriented mountain that is about 4.5 miles in length (Figure 1). Elevations where turbines would be located range from about 1,850 to about 2,240 feet (564-683 m) ASL, although there are some areas where roads will be located that are at lower elevations. The Project site is situated to the north and south of a hardtop road that extends from east to west through the site. Lempster Mountain actually consists of Kennedy Hill, Silver Mountain, and Pollard's Hill, with lower elevations between these three high elevation sites. The land drops off steeply to the west, such that there is a nearly linear hillside that extends for about 4 miles (6.4 km). To the north and south of the Project, the hills and mountains are not oriented in any particular direction. Turbines would be situated along the highest elevations along these hills.

About 84% of New Hampshire is forested with most of the southern portion of the state, including the area surrounding Lempster Mountain being sugar-maple and beech-birch forest, with small amounts of red spruce and balsam fir at higher elevations. There are also some mesic forests with oak trees, especially where drainage is good and soils are thin. The state was largely cleared by about 1800 but farms were abandoned in the late 1800s. The original forests were mostly hardwood, with some red spruce, eastern hemlock, white pine, and a small amount of balsam fir. By the 1880s, about 47% of the state was forested as older farmsteads were being reforested. In the last century, as many more farms were abandoned the forests continued to cover the landscape until today the forests cover much of the state. These forests continue to age, although small scale logging operations remove small patches of forest, such that the landscape today is a mosaic. Very recently, the southern part of New Hampshire is beginning to be subdivided into small parcels and forest is becoming more fragmented (Foss 1994).

The Project site and Lempster Mountain in general are mostly forested today (Figure 2, Foss 1994)), although there are a few fields, clearings in the forest, and a mosaic of forest types and ages within the Project boundary. The common trees on site are sugar maple, red spruce, white pine, white ash, northern red oak, yellow birch, American beech, red maple, along with lesser amounts of eastern hemlock, black cherry, pin cherry, gray birch, paper birch, black birch, red pine and Norway spruce (mostly planted). There are also some striped maple and trembling aspen. Because of logging in some areas, the trees are dense stands of small trees and early succession species. In other areas the trees are more mature. Spruce areas are extensive, especially at the higher elevations of There are balds at the tops of Silver Mountain, with few trees. These balds are about 200 m in diameter. Those trees include gray birch and small red spruce, interspersed with grassy areas.

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Nearly pure stands of red spruce occur near the top of Silver Mountain and the tops of higher hills to the north (south of Mountain Road, Figure 2). The spruce at the tops of these mountains can be dense and the stands fairly large and mature. There are also young, dense patches of spruce here and there. The area just to the south of the radio towers was being logged during the site visit. In the northern portion of the Project site on Kennedy Hill (north of Mountain Road), the lower slopes were mixed deciduous and coniferous forest. Some of these areas were small secondary growth trees, but mostly more mature woodland. In this area the most common trees were red spruce, white pine, red maple, paper birch, yellow birch, northern red oak, American beech, and white ash, as well as mountain ash, sweet birch, trembling aspen striped maple, black cherry, pin cherry, eastern hemlock (few), gray birch and some balsam fir. This mosaic included some rather large stands of pure red spruce (Figure 2) on the slopes and at the summit of Lempster Mountain, Pollards Hill, and Kennedy Hill.

Just south of Pollards Hill there are large fields that are cow pastures, near the Odella residence. On Lempster Mountain there were small, rocky/grassy openings with patches of small red spruce scattered within stands of dense red spruce at the summit. (Two Gray-cheeked/Bicknell's Thrush were observed at this site but species identification was not possible. The dense spruce on these mountains appears to be suitable for this species.)

Some wet, boggy areas were found near Pollards Hill. There was standing water during the site visit and some sedges present. The habitat was suggestive of Olive-sided Flycatcher habitat, if there were openings. Spruces in places may have been black spruce.

Overall, the forests are generally large and relatively contiguous. The quality of the forests on site as nesting habitat for northern temperate and boreal nesting species is generally high-very good. The fact that the forests are a mosaic of ages, suggests that they support a very diverse assemblage of species. The habitat must be considered relatively high quality nesting habitat for birds and other forest animals.

There are several small lakes and ponds (May, North, Sand, and Long Ponds) in the general area, some of which are within about 1-2 miles (1.6-3.2 km) from turbine locations. All of these are relatively small. There are no large lakes or rivers within 10 miles (16 km) of the Project site, although Dodge Brook is to the west of the site, more than 1 mile away.

Forestry and recreation are the main land-uses at the Project site and in the general area. There are several homes within or immediately adjacent to the Project site. Other infrastructure within the Project includes a communication tower. There are likely small, isolated wetlands on site and there are certainly small wetlands immediately adjacent to the site.

Site Visit to the Lempster Mountain Wind Power Project, Sullivan County, New Hampshire

The Lempster Mountain Wind Power Project site was visited on September 13-15, 2004. In addition to walking the site, the area surrounding the site was toured by automobile. The weather during the site visit was mild and clear. Observing habitat and birds was unimpeded by

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weather. The areas where turbines would be located are mostly forested, although there are trails and logging roads scattered throughout the project, as well as some fields. During the visit, an effort was made to observe the bird life and habitat on and adjacent to the site, and determine what birds or ornithological phenomena might be present on site or nearby.

A total of 69 bird species (numbers observed given in parentheses, but only for hawks and less common species) were observed during the site visit. These were mostly nesting species and a number of early fall migrants. The following species were seen on the Project site Great Blue Heron, Turkey Vulture, Canada Goose, Sharp-shinned Hawk (8), Cooper's Hawk (1; New Hampshire threatened species), Red-shouldered Hawk, Broad-winged Hawk (28), Red-tailed Hawk (6), American Kestrel (4), Merlin, Ruffed Grouse, Wild Turkey, Mourning Dove, Yellow-bellied Sapsucker, Downy Woodpecker, Hairy Woodpecker, Northern Flicker, Pileated Woodpecker, Eastern Wood-Pewee, Eastern Phoebe, Blue-headed Vireo, Red-eyed Vireo, Blue Jay, American Crow, Common Raven, Tree Swallow, Barn Swallow, Black-capped Chickadee, Red-breasted Nuthatch, White-breasted Nuthatch, Brown Creeper, Winter Wren, Golden-crowned Kinglet, Eastern Bluebird, Gray-cheeked/Bicknell's Thrush, Swainson's Thrush, American Robin, Gray Catbird, European Starling, Cedar Waxwing, Tennessee Warbler, Nashville Warbler, Northern Parula, Chestnut-sided Warbler, Magnolia Warbler, Cape May Warbler, Black-throated Blue Warbler, Yellow-rumped Warbler, Black-throated Green Warbler, Blackburnian Warbler, Pine Warbler, Palm Warbler, Blackpoll Warbler, Black-and-white Warbler, American Redstart, Common Yellowthroat, Scarlet Tanager, Eastern Towhee, Chipping Sparrow, Field Sparrow, Song Sparrow, Lincoln's Sparrow (2), Dark-eyed Junco, Rose-breasted Grosbeak, Red-winged Blackbird, Purple Finch, and American Goldfinch.

The hawks seen were apparently migrating southward, following the mountaintop. These birds were mostly at high altitudes, although 2 American Kestrels, 4 Red-tailed Hawks, and a Merlin were flying at altitudes below about 150 feet. The dates of the observations coincide with the migration season of many North American hawks and for some species it is the peak or beginning of migration. Some of the songbirds were likely migrating, although some may have been nesting species that were about to initiate migration.

Lempster Mountain Wind Power Project, Sullivan County, New Hampshire - Avian Overview

Nesting Birds

The New Hampshire Department of Game and Fish and U.S. Fish and Wildlife Service list of endangered and threatened species (Table 1) were used as references to determine whether these species might be at risk at the Project site. The habitat on the site does not appear to be suitable for nesting by any federally listed bird species (Table 1). It is also unlikely that any of these species nest within several miles of the Project site, although dispersing or migrating Bald Eagles (federally threatened) could forage at ponds within 1-2 miles (1.6-3.2 km) of the Project site. The forested habitat where turbines would be located are not suitable for foraging by these animals.

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With respect to New Hampshire endangered and threatened species, the habitat on and adjacent to the site may be suitable for nesting or foraging (Table 1). The habitat on site is either suitable or marginally suitable for Cooper's Hawk (threatened). If any listed species nest on site, that species is the likeliest candidate. Although the habitat does not look suitable for Three-toed Woodpeckers (threatened), there is a remote possibility that this species will visit the spruce forests on site on rare occasions. The site certainly does not appear to be optimal nesting habitat for this species, however. Other listed species, including Common Loon (threatened), Pied-billed Grebe (endangered), and Osprey (threatened) could nest or forage at the ponds within 1-2 miles (1.6-3.2 km) of the site. The habitat on Lempster Mountain at the Project site, however, is not suitable for nesting or foraging by these species and it is unlikely that they will be within about 1 km of any turbine, except during migration and, perhaps while dispersing to foraging sites away from their nesting sites.

A letter requesting a list of endangered and threatened species that might occur at Lempster Mountain was sent to the U.S. Fish & Wildlife Service. They responded stating that "based on information currently available … no federally listed or proposed, threatened or endangered species or critical habitat… are known to occur in the project area." They further stated that Bald Eagle (threatened) and Indiana bat (endangered) "are migratory and their seasonal movements are not well known." They further stated that there were no known occurrences of "Indiana bats east of the Green Mountains in Vermont." With respect to Bald Eagles, they stated that "their presence is probably irregular and transitory."

A letter from the New Hampshire Fish and Game, Nongame and Endangered Wildlife program revealed "no known locations of state listed species found within the boundary of the project." They further stated that "there is high potential for impacts to a variety of wildlife species under the proposed project." They also stated that state listed species may occur in the "general area" including Three-toed Woodpeckers and some non-bird listed species. They gave no further details regarding these species, other than a list of potential non-bird species.

Two other sources of data and information were examined to determine the status and presence of listed and common species as nesting birds in this portion of Sullivan and nearby Merrimack County, as well as at the Lempster Mountain Wind Power Project site. These included USGS Breeding Bird Surveys (BBS), and the New Hampshire breeding bird atlas (Foss 1994). Detection of any listed species within 5+ miles (8+ km) of the Project site would suggest that habitat suitable for these species may be present on or adjacent to the proposed turbines.

Four BBS routes were used to evaluate risk to nesting birds at the Lempster Mountain Wind Power Project site (Table 2). These BBS routes were located in Sullivan, Merrimack, Cheshire, and Grafton Counties, ranging from 5 to 17 miles (8-27 km) from the Project site. The Marlow BBS was closest to the Project site and was 5 miles (8 km) south of the Project. The other sites were to the north, south, and northeast of the Project. Together these four routes provide robust information regarding the birds likely to nest within the Project boundaries and, therefore, potentially impacted by the Project. Data from a ten-year period were examined, commencing in 1994.

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The Breeding Bird Survey is sponsored by the United States Geological Survey and is conducted each year. A BBS is a 24.5 mile (39.4 km) road survey of nesting birds. Fifty, three minute stops are made at 0.5 mile (0.8 km) intervals during which all birds seen or heard within 0.25 miles (0.4 km) are recorded. The survey is repeated several times each spring during the nesting season.

The coverage of the four Breeding Bird Surveys used in this analysis, years surveys were done, numbers of species found, as well as presence of endangered and threatened species are summarized in Table 2. The BBSs revealed no federally listed avian species nesting in the general area. In addition, few New Hampshire listed species were observed on the BBSs. On the Marlow and Walpole BBS routes, no state listed species were found. However, on the Lempster BBS, 2 listed species were observed. Two Purple Martin (New Hampshire endangered) were observed during 1 of the 10 years of observations and a single Grasshopper Sparrow (threatened) was observed. On the Wilmot BBS, 3 listed species were observed; including a single Pied-billed Grebe (endangered), a single Northern Harrier (endangered), and a single Common Nighthawk (threatened) were observed. Of these 5 species, Purple Martin, Grasshopper Sparrow, Common Nighthawk, and Northern Harrier are species confined mostly to lower elevations and situations where there are wide open habitats, such as grasslands (Grasshopper Sparrow and Northern Harrier), large marshes (Northern Harrier), or large lawns (Purple Martin). Common Nighthawks in New Hampshire are often associated with residential and even urban/suburban areas. Pied-billed Grebes nest mostly in marshes or in emergent vegetation adjacent to open water of marshes, lakes, and ponds, as well as some rivers. None of these species are likely to be on the Project site because of habitat constraints. It is possible that any of them could be present as transients, but will be present in small numbers during dispersal or migration as opposed to being present for nesting or foraging purposes.

A majority of the species found in the general area of the Project site are common songbirds of forest, forest edge, and brush. There were lesser numbers of birds common to old-fields and grasslands. A few waterfowl and waterbirds were found on these BBS routes. The BBS routes were in forested areas with some fields. Species richness was moderate (number of species) with a minimum of 48 species in one year on the Lempster BBS to 72 species in one year on the Marlow BBS. The usual number of species was in the high 60s, with the cumulative number of nesting species on all four BBS routes being about 80 species.

Few raptors were reported, with only American Kestrel, Red-tailed Hawk, Broad-winged Hawk, Red-shouldered Hawk, and Sharp-shinned Hawk being reported in only a few years of the decade of data examined from the four BBS routes. Waterfowl included species such as Hooded and Common Merganser, Canada Goose, American Black Duck, Mallard, and Wood Duck being present in some locations. Songbirds included both forest interior nesting species such as Black-throated Blue Warbler, Blackburnian Warbler, Ovenbird, Northern Parula, Red-eyed Vireo, Wood Thrush, Veery, and Hermit Thrush, as well as other area sensitive species such as Canada Warbler. There were also various edge species and species that are indicative of forest fragmentation such as Chestnut-sided Warbler, Yellow Warbler, Blue Jay, American Crow, and Brown-headed Cowbird.

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The New Hampshire BBA project was conducted in 1981-1987 (Foss 1994). A total of 178 "priority blocks" were surveyed in the state for a total of 16.7% of the state being covered. There were 8 priority blocks within Sullivan County and 16 within Merrimack County, just to the east of the Project site. Such complete coverage provides a high level of confidence as to what species nest in the Sullivan and adjacent counties, as well as what might be expected to nest on the Project site at Lempster Mountain. One of the priority blocks was located within about 2 miles (3.2 km) of the Project boundary.

The BBA work detected between 50-74 species of nesting birds within priority blocks near the Lempster site. Between 25 and 49 species were confirmed from blocks in that area, with 24-64 species confirmed within the Sullivan County blocks. This is very close to the numbers of nesting species found on the BBSs that were examined.

A majority of the bird species found on the BBA nest in Sullivan and adjacent Merrimack Counties were birds of forest, edge, and brush, with lesser numbers of grassland and aquatic/marsh habitats also being found. As with the BBS data, some interior forest nesting species and sensitive forest nesting birds were present. Some of these species are priority species as listed by the national Partners In Flight program. These include Black-throated Blue Warbler, Canada Warbler, Wood Thrush, and some others. Very few raptor nesting records were found for the area.

With respect to federally listed species, there was no evidence from the Atlas project that any endangered or threatened species nest on or near the Project site. With respect to state listed species, three were found on the New Hampshire atlas project within about 5 miles (8 km) of the Project site. Northern Harrier (endangered) was possibly nesting 5 miles (8 km) east-southeast of the Lempster site, Common Nighthawk (threatened) was probably nesting just across the Hillsborough/Merrimack County border, and Sedge Wren (endangered) was possibly nesting in the block adjacent to the Project site. None of these species are likely to be on the Project site because the habitat is not suitable for them there. All of these species require open country and none nest within forests or forage within wooded areas. Overall, the Atlas did not suggest the presence of federal or state listed species.

Overall, the habitat assessment, BBS, and BBA did not provide indication that listed species are likely to nest on the Project site or immediately adjacent to it. However, the contiguous nature of the forest and types of vegetation found throughout much of the Project site suggest that habitat is high quality nesting habitat for forest interior species, including some Partners In Flight priority species.

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Table 1. New Hampshire and federal (US) endangered (E) and threatened (T) species. Also included is habitat suitability for nesting at the Lempster Mountain project site and within 1 mile of the Project site: NS = not suitable, MS = marginally suitable, S = suitable. Habitat within 1 mile of the Project that is suitable or marginally suitable for nesting or as migration stopover habitat or foraging habitat is also noted.

Species	Status	Habitat Suitability/Within 1 Mile
Common Loon	Threatened	NS/MS? & migration stopover & foraging
Pied-billed Grebe	Endangered	NS/S-migration stopover & foraging
Osprey	Threatened	NS/MS & migration stopover & foraging
Northern Harrier	Endangered	NS
Bald Eagle	Endangered (US-T)	NS/MS-foraging, migration
Cooper's Hawk	Threatened	MS?
Golden Eagle	Endangered	NS
Peregrine Falcon	Endangered	NS
Upland Sandpiper	Endangered	NS
Piping Plover	Endangered (US-T)	NS
Roseate Tern	Endangered (US-E)	NS
Arctic Tern	Threatened	NS
Common Tern	Endangered	NS
Least Tern	Endangered	NS
Three-toed Woodpecker	Threatened	NS-MS?
Common Nighthawk	Threatened	NS
Purple Martin	Endangered	NS
Sedge Wren	Endangered	NS
Grasshopper Sparrow	Threatened	NS

Table 2. USGS Breeding Bird Surveys examined to evaluate species likelihood at the Lempster Mountain Wind Power Project site, Sullivan County, New Hampshire area (1994-2003).

Number and Name	County	Years	Species – Min - Max	Distance / Direction From Project
58014 - Marlow	Cheshire/Sullivan	10 Years	59 – 72 Species	5 miles S
58015 - Lempster	Sullivan	10 Years	48 – 68 Species	6 miles N
58013 - Walpole	Cheshire	10 Years	56 – 63 Species	13 miles S
58011 - Wilmot	Merrimack/Grafton	10 Years	52 – 71 Species	17 miles NE

Migrating Birds

In general, there are few major or significant migration stopover sites or migration "pathways" in southwestern New Hampshire. This is the case for Sullivan County and the area surrounding the Lempster Mountain Project site. The topography and habitat at the Project site and nearby provides little indication of an ecological magnet for migrants (Berthold 2001,

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Alerstam 1990). The topography on site and surrounding the Lempster project is not similar to locations where large numbers of migrants are found, although the linear nature of Lempster Mountain could serve as a leading line for some daytime migrating birds such as hawks. In addition, the Connecticut River Valley, some 13 miles (21 km) west of the Project site. The sections that follow examine the migration of songbirds, hawks, and waterbirds (waterfowl, shorebirds, and others).

Nocturnal Songbird Migration

The literature has few, if any, references regarding the night migration behavior of songbirds in southwestern New Hampshire. However, it is likely that the night migration of songbirds through most of southern New Hampshire occurs over a broad front with few or no large concentrations of these birds during flight. This statement is based on the fact that there is little evidence that songbirds follow topographic structures such as ridges and valleys during night flight and that most night migration occurs over broad fronts (Berthold 2001, Alerstam 1993, Eastwood 1967). Berthold (2001) went so far as to say, "individuals originating from geographically dispersed breeding areas cross all geomorphological features (lowlands, mountains, rivers, and so on) along their routes without deviating much from the orientation of their initial tracks." Berthold uses the term "broad fronts" to describe these migrations. Radar studies conducted in various locations in the northeastern United States suggest that migration is broad front (Cooper et al. 1995, Cooper and Mabee 1999, Cooper et al. 2004a, 2004b, Diehl and Larkin 2003).

Perhaps the best evidence from eastern North American to support the contention that birds do not follow ridges is a study by Cooper et al. (2004) from the Allegheny Front, a long, linear ridge in West Virginia. That study showed that night migrants simply crossed the ridge at an oblique angle rather than following it. This finding is supports the broad front migration, because the flight direction of birds was not influenced by a major ridge and because the numbers of migrants observed were no larger than at other locations in the northeastern states where radar studies had been conducted. In addition, the altitude of migrants as they flew over the Allegheny Front averaged between 400 and 500 m *(1,312-1,640 feet) AGL, similar to the altitude of migrants at other locations away from ridges.

There are two accounts of birds migrating in the northeastern United States that suggest birds do, at times, change migration direction when confronted by topographic features. In northern New Hampshire at the Franconia Notch at the northern edge of the White Mountains, a radar and ceilometer study showed that birds may turn when they encounter the massive topographic features of these mountains (Williams et al. 2001). At this site, birds flying over terrain that is about 1,400 feet (427 m) ASL are confronted by a massif that extends to more than 4,500 feet (1,372 m) ASL within a few kilometers. This is a difference of about 3,000 feet (nearly ~950 m) in a very short distance, which is rarely encountered by migrants. This finding is similar to the European findings of bird flying through passes in the Alps and diverting around the Alps (Bruderer and Liechti 1999). However, the Williams et al. (2001) report provides little information on high flying migrants or migrants flying in other than a restricted location near Franconia Notch, so there is limited information from this site.

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A study done using ceilometers at two sites, along the Hudson River and in the Helderberg Mountains, near Albany, New York, showed that birds might have been following the Hudson River (or the lights along the River) during fall migration (Bingman et al. 1982) when winds were strong from the west. That study did not determine the distance these birds followed the river under those circumstances.

Even migrants confronted by the Great Lakes in upstate New York (eastern Lake Erie and Lake Ontario) do not turn when they reach the lake shores during night migration (Diehl and Larkin 2003) and continue to cross the lakes as if they were not present. These birds do, however, put down for stopovers along the lakeshores, especially in the hours before dawn. The evidence is overwhelming that most night migrating songbirds are spread across a broad front over most types of topography encountered by these birds.

There is one topographic feature in southwestern New Hampshire that may serve as a stopover area for night migrating songbirds. That feature is the Connecticut River Valley, which traverses a habitat/topographic corridor that extends roughly north to south between New Hampshire and Vermont. It is likely that this area is an important stopover area for migrating songbirds because of the riparian nature of the habitats that line the banks of the Connecticut River. That valley is a relatively long distance from Lempster Mountain and birds that may use the Connecticut Valley would not be close to the Project site.

The geographic location and topography of the Lempster Mountain Wind Power Project site are very similar to the conditions throughout much of southern New Hampshire (and New England) away from the ocean and away from the Connecticut River Valley. Therefore, there is no evidence to suggest that the Project site experiences anything but broad front migration and there are not likely to be concentrations of night migrating songbirds at the site either during flight or during migratory stopovers.

Hawk Migration in Sullivan County and Surrounding Area

New Hampshire has a history of more than 30 years of hawkwatching, yet there are no known major hawk migration sites or corridors in inland New Hampshire. Although tens of thousands of hawks of about a dozen species must migrate through New Hampshire annually, they appear to be spread fairly uniformly over across a broad front. There are likely to be concentrations along the Atlantic Coast of New Hampshire, but there is little evidence to support this contention.

Zalles and Bildstein (2000) in their directory of significant hawk migration sites list no sites from New Hampshire. Although there are no major hawk watching sites, there are, several lesser hawk watching sites, mostly in southern New Hampshire (Hawk Migration Association of North America Journal and website [www.hmana.org]). The results from these sites are listed in the Journal of the Hawk Migration Association of North America (late 1990s and early 2000s). These sites are scattered and none of them experience major hawk flights like sites farther south in Massachusetts (Mount Watchusett) or farther south (Cape May, New Jersey, Hawk Mountain, Pennsylvania). Sites such as Little Round Top, Prospect Hill, and Peter Wood Hill can be found on mountaintops. Most of these sites report a dozen to several dozen hawks per day during the

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peak of the season and on a few days they report more than 100 hawks. Broad-winged Hawks account for a vast majority of the hawks observed and the numbers reported from a given site have numbered greater than 1,000 birds. However, these hawks can be seen migrating in fairly decent numbers on just about any hilltop in southern New Hampshire because they are the most numerous of hawks in the area and they do not follow ridges to any great extent. The larger counts reported from single days are generally of a few flocks that contain dozens to hundreds of individuals, a function of the social behavior of these birds.

It is noteworthy that during the site visit in September, more than a dozen hawks (see species list above) were observed as they migrated southward. These birds used wind deflected off the west side of the mountain for lift. Most were flying at relatively high altitudes (several hundred to nearly 1,000 feet AGL.

Waterfowl, Waterbirds, and Shorebirds.

There are no large lakes, marshes, mudflats, or the types of ecological magnets that attract these types of birds, which suggests that these types of birds do not congregate on or over the Lempster project site. Bellrose (1976) indicated that there was a modest migration of waterfowl spread over southern New Hampshire, such that the area is not an important migratory corridor or stopover area for waterfowl. There are small lakes and ponds within 1 to 2 miles (1.6-3.2 km) to the east of the Project. These are very small and probably attract relatively few waterfowl, loons, grebes, or other waterbirds, during fall or spring migration. There are also likely to be some migrations and stopovers of some waterfowl species along the Connecticut River although the overall numbers are not likely to very large.

With respect to the waterfowl and other waterbirds that do migrate over southern New Hampshire, most likely fly over the site at night (to a lesser extent during daytime) at altitudes in excess of 500-1000 feet or more (152-304 m; Bellrose 1976), which has been confirmed with radar at many locations (reviewed by Kerlinger and Moore 1989).

Wintering Birds

The winter climate in south-central New Hampshire is harsh. The relatively high elevation of the Lempster Mountain Wind Power Project site is subject to strong winds, low temperatures, and deep snow. Snow can come relatively early and remain for several months, resulting in deep snow during much of the winter. The general area is relatively inhospitable in winter to most birds. Food is also scarce, resulting in a low diversity and small number of birds during this season, especially at higher elevations and exposed habitats. Winter generally begins in mid-November and extends into mid-March). Snow often remains into April.

The primary sources of information on winter birds near the Lempster site were four National Audubon Society Christmas Bird Counts (CBCs) from 1994-1995 through 2003-2004. These sites were located in the general area of the Lempster site and out to about 23 miles (37 km; Table 3). The closest of these to the project site was the Lake Sunapee CBC, which was only 2 miles (3.2 km) north-northeast of the Project. The Keene CBC was about 12 miles (19

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km) south-southwest of the Project site, whereas the Peterborough-Hancock CBC was 13 miles (21 km) southeast of the Project site. The CBCs used are spread rather evenly around the Project site in different directions. Each of these Christmas Counts included the area within a 15-mile (24 km) diameter circle, an area of about 177 square miles (453 square km). Thus, all four CBCs covered a total area of 708 square miles (1,812 square km). More than 60 people participated in most recent years on the CBCs at these four sites, although the numbers varied greatly during the ten-year period examined. The birds observed and habitats present include those present on the four CBCs and can be considered representative of the Project site.

Christmas Bird Counts provide an excellent overview of the birds that inhabit an area during winter. Each winter within about 10 days of Christmas, dozens of birders comb their local CBC area counting all birds encountered. These birders search during the day and to a lesser extent at night, in the entire area encompassed within a particular count area. In addition, they scout for birds during that season, especially during the "count week" period, to prepare for the actual count day. Although most of these birders are unpaid amateurs, they are usually proficient or highly skilled observers. The CBC count data are used for various types of conservation purposes including population tracking and determining geographic range and abundance of species by various environmental groups and government wildlife agencies. In the analyses that follow, all birds seen on the counts and during count weeks were included. The most recent ten year period for these counts was examined.

Table 3. Audubon Christmas Bird Count data sets used to assess avian risk at the Lempster Mountain Wind Power Project site, Sullivan County, New Hampshire. Data included ten years of CBC data from 1994/1995 to 2003/2004. Included are distance and direction from the Project site to the CBC circle and minimum and maximum number of species observed.

Christmas Bird Count / County	Years	Number of Participants	Distance and Direction	Number of Species – Min / Max
Lake Sunapee, Sullivan & Merrimack Counties	10	10 – 17 People	2 miles NNE	36 – 50 Species
Keene, Cheshire County	10	9 – 38 People	12 miles SSW	38 – 58 Species
Peterborough-Hancock, Hillsborough/Cheshire Counties	10	22 – 44 People	13 miles SE	45 – 52 Species
Concord, Merrimack County	10	8 – 19 People	23 miles W	50 – 57 Species

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Table 4. New Hampshire endangered (E), threatened (T), and federally threatened (US-T) species found on the four Audubon Christmas Bird Counts listed in Table 3 between 1994 and 2004. Provided are the CBC site and numbers of individuals found in the number of years found on each of the CBCs.

Species	CBC	Number of Individuals (Range) Per Year	Number of Years Observed
Bald Eagle – US-T	Lake Sunapee	1-2 Per Year	2 Years
	Concord	1-3 PerYear	4 Years
	Peterborough-Hancock	1 Per year	4 Years
	Keene	1-3 Per Year	5 Years
Common Loon - T	Lake Sunapee	1-5 Per Year	7 Years
	Keene	1-5 Per Year	3 Years
Pied-billed Grebe - E	Lake Sunapee	1 Per Year	1 Year
	Concord	1 Per Year	1 Year
Cooper's Hawk - T	Lake Sunapee	1-2 Per Year	3 Years
	Concord	1-2 Per Year	6 Years
	Keene	1 Per Year	1 Year
	Peterborough-Hancock	1-2 Per Year	2 Years
Peregrine Falcon - E	Peterborough-Hancock	1 Per Year	1 Year

The diversity and number of birds varied between years and sites. The maximum number of species ranged between 50 and 58 species and the minimum number ranged between 36 and 50 species (Table 3). There was not a large difference among the sites, although there seemed to be slightly greater diversities of birds at the Concord CBC, which was the farthest from the site. Closer to the site, the Keene CBC had the second greatest diversity of species (Table 3). Overall, the 4 CBCs examined had fewer species than sites in coastal New Hampshire and Maine, which often have CBCs in excess of 90-100 species. The inland 4 CBCs lacked diversity because of the lack of open water. In midwinter at the Lempster project site, there is virtually no open water, so no waterfowl or waterbirds will be found there in winter.

The types of birds that dominated the 4 CBCs examined were mostly forest and residential type bird species. There were several species of sparrows, woodpeckers, corvids, raptors, finches, owls, and other species that are typically found in forests and residential neighborhoods. The latter attract and hold several species of birds that might not be present without bird feeders or would be present in much lower numbers. Most of these species are relatively common. There were also a few species of waterfowl present, many of which were diving ducks, which can survive away from the frozen edges of lakes and ponds, as well as in rivers. Raptors present included mostly Red-tailed Hawks (most numerous), Sharp-shinned Hawks, Cooper's Hawk, and many fewer individuals of several other species.

Only a small subset of the species found on the CBCs will be found on the Lempster site during winter because the site is primarily forested. Species most likely to be encountered on the Project site in winter include chickadees, woodpeckers, grouse, ravens and some jays, finches, owls, perhaps crossbills, and a few others. Raptors on site during winter are likely to be few and far between.

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No federally endangered species were present on any of the counts from the 4 CBCs examined over the ten-year period. Bald Eagle, now federally threatened (and proposed for delisting in 2000), were seen in small numbers on all of the CBCs (Table 4), but they were not seen in all years. A maximum of 3 individuals was observed in any one year on a Count. These birds are most numerous where there is open water, mostly in early winter. This species most often inhabits areas near open water because they eat fish, crippled and sick ducks, or carrion, if it is available. These birds will not likely be present on mountaintops in the winter because the habitat is not suitable and food is not likely to be present. So, they will rarely, if ever, be found at the Lempster project site.

There were 2 New Hampshire endangered and 2 threatened species present on the CBCs (Table 4). Of these, Pied-billed Grebe (endangered) and Common Loon (threatened) will not be found on the Project site because they require aquatic habitats, which do not occur on the Project site or within 1 mile of where turbines will be situated. It is possible that those nearby small lakes/ponds will be frozen by late December, thereby being unsuitable habitat for these species during winter. Peregrine Falcons (endangered) are also unlikely to be found on the Project site. Peregrines feed on birds, mostly birds associated with water. These birds do not forage in forested habitats in any season and there is little food for them on the Project site during winter. Cooper's Hawk (threatened), could possibly be found in midwinter at the Project site, although their abundance will likely be low and they are not likely to be on site often. These birds eat small mammals and other birds, both of which will be limited in winter. They are far more likely to be present in residential neighborhoods and suburban areas during winter, where there are abundant supplies of small and medium sized passerine birds around homes and feeders.

In summary, no species that are listed as federally threatened or endangered will be found on site in winter and it is highly unlikely that state listed species will be present on the Project site during winter. Of the listed species found on CBCs near the Lempster project site during winter, only Cooper's Hawk might be present during winter and even then it will be present in very small numbers or only a portion of the time. Most species that will be found on site during winter are common species of forest and forest edge and abundances of these birds are not likely to be great because of the harsh conditions and habitat that is suitable for few wintering species.

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Important Bird Areas, Parks, Nature Preserves, Sanctuaries, and Sensitive Habitats near the Lempster Mountain Wind Power Project Site, Sullivan County, New Hampshire

Important Bird Areas. There are no Important Bird Areas within or within 20 miles (32 km) of the Lempster Mountain Wind Power Project (Audubon New Hampshire website).

Nature Conservancy Properties. The Nature Conservancy (TNC) does not have any preserves within about 7-8 miles (11-13 km) in of the Project site. The nearest is near Antrim in northern Cheshire County to the south of the Project site.

National Parks, Wildlife Refuges, and Forests. There are no national parks, wildlife refuges, or forests within 20+ miles (32 km) of the project site.

New Hampshire State Parks, Forests, and Game/Wildlife Management Areas. The Pillsbury State Park is greater than one mile (1.6 km) northeast of the Project site and wraps around the eastern boundary of the site. Dodge Brook State Forest is about 0.7 miles (~1 km) to the southwest of the Project site.

Audubon Society Sanctuaries. There are no Audubon Sanctuaries within 10+ miles (16 km) of the Project site, although there are about 6 that are within 15-20 miles (24-32 km).

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Risk to Birds at the Proposed Lempster Mountain Wind Power Project Project

Review of Risk to Birds at Wind Power Plants in the United States and Europe

Perhaps the best means of assessing risk to birds at prospective wind power development sites is to compare the avifauna, geographic and topographic settings, and habitat at that site, with levels of risk determined empirically at existing wind turbine sites. By comparing the types of species present or likely to be present, numbers of individuals, seasonal presence, and behavior of birds that nest, forage, migrate through, or winter on a proposed wind power site with existing facilities where risk has been determined empirically, probabilistic assessments of risk can be made. A review of empirical studies of avian risk follows.

Two general types of impacts are known to occur at wind power projects: (i) habitat alteration/disturbance with resulting avoidance and displacement, and (ii) fatalities resulting from collisions with turbines, meteorology towers, and other infrastructure. These two types of impacts are detailed below.

Habitat Disturbance, Avoidance, and Displacement.

Habitat alteration and disturbance resulting from construction activity and new wind turbines sometimes render a site less suitable for nesting, foraging, or resting for some birds. Impacts from human activity and presence of large structures are not entirely understood, but are becoming better documented. The footprint of turbines, roads, and other infrastructure is generally a small percentage of the site and after construction; other land use is relatively unchanged. The true amount of wildlife habitat altered by a wind power project, however, can extend beyond the functional footprint of the project because of the presence of tall structures and increased human activity. The presence of new infrastructure – primarily tall turbines – has been examined to determine whether birds avoid or are displaced from an area by new features on the landscape.

Disturbance/avoidance/displacement studies have focused mainly on grassland and other open country birds. At a large wind power plant in southwestern Minnesota, reduced nesting was detected among birds nesting in Conservation Reserve Program grasslands close to wind turbines. Leddy et al. (1999) found that nesting of many grassland species was inhibited within about 80 to nearly 200 m of turbines. A gradient of impacts was demonstrated such that disturbance was greatest within the first 100 m of a turbine and less at greater distances. This means that after construction of the turbines some birds are displaced such that they do not nest or forage close to the turbines or do so in reduced numbers.

Nesting activities of Mountain Plovers (a grassland nesting species) at the Foote Creek Rim Wind Plant in Wyoming declined after turbines were built, as did their nesting productivity (Johnson et al. 2000). Successful nesting by plovers was noted within 200 m of operating turbines. Thus, the area impacted extended beyond the physical footprint of the project.

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In the Altamont Pass Wind Resource Area of California (APWRA) where there are very large numbers of raptors and grassland nesting songbirds, perching occurs regularly on the lattice towers and guy wires of older turbines. In a study in the APWRA, Red-tailed Hawks trained for falconry in Idaho were exposed to turbines to study their flight behavior. Upon first seeing the turbines at 100+ feet (32 m), the birds would not fly, but they habituated rapidly. Within weeks their behavior appeared comparable to resident Red-tailed Hawks (R. Curry, personal communication). Unlike most other sites, turbines have been present in the APWRA for about 20 years, giving birds time to habituate.

In Europe studies have shown that some waterfowl, shorebirds, and grassland songbird species can be displaced by turbines. For example, migrant shorebirds were displaced by 250-500 m (Winkelman 1990). In Denmark, some migrant shorebirds were displaced by up to 800 m by the presence of turbines (Pederson and Poulsen 1991). Other studies have shown that some shorebirds and other birds can habituate to turbines, but do so to varying degrees (Ihde and Vauk-Henzelt 1999, Winkelman 1990). No studies have examined behavioral changes or habituation of birds to wind turbines over long periods (5 to 10 years) post construction, so it is not known if these species are permanently displaced.

Other studies from Denmark show species specific differences in avian avoidance patterns near wind turbines (Larsen and Madsen 2000, Percival 1999, Kruckenberg and Jaene 1999). For example, Pink-footed Geese (Larsen and Madsen 2000) would not forage within 50 m of wind turbine rows or within 150 m of turbine clusters. An impact gradient was demonstrated where few of these geese foraged within 100 m of wind turbines than foraged farther from the turbines. Barnacle Geese, however, foraged within about 25 m of turbines, showing they are less sensitive than Pink-footed Geese (Percival 1999). White-fronted Geese showed greater displacement and did not forage within about 400-600 m of wind turbines (Kruckenberg and Jaene 1999).

Anecdotal information about Canada Geese from the Fenner Wind Power facility in New York State (this author) suggests that these birds are hardly displaced by wind turbines. These geese readily habituate to human structures and activities. The above examples demonstrate that different species react differently to wind turbines and that habituation does occur in some species. The studies do not show how long the habituation process requires.

With respect to forested habitats, like the Lempster site, there have been very few studies of the impacts of wind turbines, although studies of forest fragmentation from other sources are available. Perhaps the only postconstruction avian study a forested site was at the Searsburg, wind power project (11 turbines) in the Green Mountains of Vermont (Kerlinger 2000a, 2002). Point count surveys of breeding birds in this mountaintop forest conducted before and after the turbines were erected showed that some forest nesting birds such as Blackpoll Warbler, Yellow-rumped Warbler, White-throated Sparrow, and Dark-eyed Junco apparently habituated to turbines within a year of construction. Conversely, Swainson's Thrushes and, perhaps, some other species seemed to move away from the turbines or clearings. It was not determined if the former species nested near the turbines, but they certainly foraged and sang within forest edge 100 feet (30 m) from turbines.

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Hawks migrating in fall at the Searsburg site did not seem to fly close to a hill with newly constructed turbines after turbine construction (Kerlinger 2000b). These migrants may have been avoided the novel structures.

The above studies suggest that disturbance/displacement by wind turbines is more pronounced among grassland and other open country birds than among forest species. The latter species may not be displaced because in the forest, tall structures often tower over their heads while they are foraging and nesting? It has also become evident from the research that that there are species specific behaviors and some species are not displaced great distances from the turbines and that some species habituate to turbines. Which species are capable of habituating is not known and impact gradient type studies are needed to quantify avoidance and displacement of various species. With new wind power facilities being proposed for and constructed in forested mountaintop habitats in the northeastern United States, rigorous studies of the disturbance and fragmentation impacts are needed, along with determinations of the extent of the areal disturbance on forest nesting birds. Such studies are particularly needed where forest interior nesting species may be impacted.

Collision Fatalities.

Avian fatalities at wind plants result from collisions with turbine rotors and guy wires of meteorology towers. Electrocutions occurred at older wind plants because electrical lines were above ground and constructed pre-Avian Powerline Interaction Committee guidelines. Collision impacts have been studied at more than 20 wind power projects in more than a dozen states in the United States (Erickson et al. 2001; Appendix III), as well as sites in Canada and Europe.

As of 2001, an estimated about 28,000 to 33,000 birds were killed at about 15,000 wind turbines in the United States (Erickson et al. (2001), averaging 2.1 birds per turbine per year. Since 2001, many more studies have been conducted, including studies at taller towers and sites in the eastern United States. Fatalities at western turbines confirmed the results of earlier studies, whereas studies at eastern sites ranged from 0 birds per turbine per year upwards to 7-8 birds per turbine per year (Kerns and Kerlinger 2004, Nicholson 2002). The fatalities in all of these studies were spread among dozens of species and taxonomic differences in collision susceptibility have become evident.

The numbers of fatalities at wind turbines per year are orders of magnitude lower than collision fatalities reported for transmission lines, windows, highways (motor vehicles), and communication towers (Erickson et al. 2001), as well as non-collision fatalities related to cat predation, hay mowing, oil pits, fishery long lines, acid rain, etc (www.currykerlinger.com, Hames et al. 2002). To give perspective, turbine collision fatalities are also orders of magnitude smaller than hunting harvests determined by professional wildlife managers (data from U.S. Fish and Wildlife Service, Martin and Johnson 2002) and lower than depredation permits allowed in the U.S. by the U.S. Department of Agriculture and the U.S. Fish and Wildlife Service. The hunting harvests amount to perhaps than 120 million birds per year and are not deemed biologically significant.

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In Europe, avian fatalities have been relatively small at wind power plants, although there are a few localities where greater numbers of fatalities have been found. In coastal Netherlands at a wind power site where there were about 18 turbines, dozens of songbirds and shorebirds of a variety of species were reported to be involved in collisions with wind turbines (Winkelman 1995) during the migration season. At another wind plant in the Netherlands, where turbines were in a saltwater lake, about 65 waterfowl fatalities were noted in one winter (Winkelman 1995). These sites are adjacent to the North Sea, where migration and wintering birds are densely concentrated into a small area with the wind turbines. That several species were killed reduced the absolute numbers of birds killed per species, thereby reducing the potential for population impacts. There are also higher fatality rates reported from Belgium, with respect to terns and gulls, at turbines located on harbors and adjacent to open water (Everaert 2002), and from northern (Navarre) Spain (internet reports) where large numbers of raptors have, apparently, been killed.

Fatalities of migrants have been relatively rare at most other sites in Europe. Perhaps the best example comes from Tarifa, Spain, where >100,000 raptors and other soaring birds, and millions of other birds converge on the Sraits of Gibraltar (Montes Marti and Barrios Jaque 1995, Janss 2000, Barrios and Rodriguez 2004, and DeLucas et al. 2004). Local Griffon Vultures and kestrels are killed on occasion, apparently because they habituate to the turbines and frequently forage amongst them. Fatalities of migrants at this site are fairly rare events.

The Altamont Pass Wind Resource Area (APWRA) is the only wind power site in the United States where risk to birds has been suggested to be significant. Raptor fatalities have been reported there for 15+ years. Golden Eagles, Red-tailed Hawks, American Kestrels, and other species collide with turbines in varying numbers. These findings suggest that raptors are the most collision-susceptible group of birds (Anderson et al. 2000), although such fatalities have not impacted regional populations. A long-term study of the Altamont Golden Eagle population by Hunt (2002) concluded that despite the high fatality rate, the regional eagle population is stable. Large numbers of gulls, ravens, vultures, grassland songbirds, and other species fly amongst the APWRA turbines, yet rarely collide with the turbines. The raptor fatalities in the APWRA are an anomaly, because they have not been demonstrated elsewhere. Studies at all U.S. wind power facilities outside of the APWRA have not revealed large or significant numbers of raptor fatalities.

Several factors (Table 5) are believed to contribute to raptor risk in the APWRA and some of these can be generalized to other species. These factors act alone or in concert with others, to produce mortality in the APWRA (Howell and DiDonato 1991, Orloff and Flannery 1992, 1996). They are:

- The world's largest concentration of turbines (N=5,400, formerly about 7,000 several years ago);
- Closely spaced turbines (<10 m [<30 feet] rotor to rotor distance) that may not permit birds to fly safely between them;
- Extraordinary numbers of foraging raptors throughout the year - a result of a superabundant population of California ground squirrels;

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- Steep topography with turbines placed in valleys and along steep valley/canyon edges where risk is greater;
- Turbine rotors that extend downward to less than 10 m from the ground, putting them in the zone where raptors forage extensively;
- Turbines mounted on lattice type towers that encourage perching by providing shade and cover from the sun and rain; and
- Small turbine rotors that revolve at high rotation rates (>40-72 rpm) making the rotor tips difficult to see.

Table 5. Comparison of known and suspected raptor risk factors at the Altamont Pass Wind Resource Area, California, with the Lempster Mountain Wind Power Project, New Hampshire.

Known or Suspected Risk Factors – APWRA	Lempster Wind Project, NH
1. Large concentrations of turbines –5,400 (in 2002)	About 12 – 20 turbines
2. Lattice towers - perching raptors	Tubular towers - no perching
3. Fast Rotating Turbine Blades - 50-72 rpm	Slow Rotating Blades ~12-18 rpm
4. Closely Spaced Turbines - 80-100 feet (<30 m) (Side to Side Turbine Spacing)	Widely Spaced Turbines >800+ feet (>250 m)
5. Turbines in Steep Valleys/Canyons	Turbines on gently to moderately rolling hills/mountains away from steep inclines
6. Large Prey Base - Attracting Raptors	Prey Base Minimal
7. Turbine rotors less than 10 m (30 feet) from ground	Turbine rotors extend down to about (35 m) 115 feet
7. Raptor and Susceptible Species Use of Area – High	Raptor Use of Area – Moderate

West of the Rocky Mountains avian mortality resulting from collisions with wind turbines has been studied at sites in California, Oregon and Washington State (Appendix III). With the exception of the APWRA, the number of fatalities reported has been small. At San Gorgonio Pass and in the Tehachapi Mountains, relatively few birds were killed (Anderson 2000) in two years of searches, with very small numbers of raptors being involved. One Golden Eagle has been found in the San Gorgonio Wind Resource Area in more than two years of study.

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At a new wind power site in Oregon, at which there are 38 turbines in farmland, a one-year study documented no raptor fatalities, 8 songbird fatalities, and 4 upland gamebird fatalities (3 of which were alien species). The actual number of fatalities was greater when searcher efficiency and carcass removal (scavenging) estimates are factored in (Appendix III).

At one of the world's largest wind power facilities, the State Line project in Washington and Oregon, the fatality rate per turbine per year was recently found to be slightly less than 2 birds per turbine per year (Erickson et al. 2002, 2003). That project has 399 turbines. Among the fatalities were a variety of species, with Horned Larks (locally nesting birds) accounting for 46% of all birds found. Six raptors of 3 species were killed and about 24% of fatalities were night migrating songbirds. The rates of avian fatalities at smaller wind power sites in Oregon (Klondike) and Washington (Nine Canyon) averaged slightly lower and higher, respectively. Birds killed were divided among night migrants, resident species, a very few waterfowl, and small numbers of raptors. The rate of night migrants killed per turbine per year in the far west has been roughly 1 bird per turbine per year or less.

Most of the projects in the far western United States, listed above, were situated in tilled agricultural fields or grazing/prairie-like habitats. It should be noted that many of the turbines involved in California studies were less than 200 feet in height and did not have FAA lights. All turbines in Oregon and Washington ranged between about were taller than 250 feet and a subset (perhaps 1 in 3 to 1 in 4) of them had FAA lights. There has been no suggestion of population impacts at any of these facilities, nor have fatalities involved endangered or threatened species.

Avian fatality studies also have been conducted at wind plants in grasslands in Colorado, Wyoming, and a small site in Kansas. After five years of systematic searches at 29 new turbines (expanded to 45 in the third year) in a short-mixed grass prairie/grazing land in northern Colorado, small numbers of fatalities were documented (Kerlinger, Curry and Ryder, unpublished). The fatalities included Horned Larks, with fewer McCown's Longspur, White-throated Swifts, 1 teal, Lark Bunting, 1 American Kestrel, and some other songbirds. The prevalence of Horned Larks on the fatality lists is likely a result of their aerial courtship flight during which they display and sing at the elevation of the rotors. At the Foote Creek Rim project, also in a short-mixed grass prairie habitat, 90 fatalities were identified, 75 of which were at wind turbines and 15 of which were at meteorology towers with guy wires (Young et al. 2003). Thus about 17% of the fatalities resulted from collisions with guy wires at the meteorology towers and likely would have been avoided by using unguyed towers. Few raptors were found dead at the Foote Creek Rim project (3 American Kestrels and 1 Northern Harrier) and 48% of the fatalities were night migrating birds. Of the migrants, no species accounted for more than 5-7 (Chipping and Vesper sparrows) individuals. Finally, no fatalities were noted by Young (2000) at the two turbine, Jeffrey Energy Center in Pottawatomie County, Kansas. For all of these studies, the numbers given above are the numbers of carcasses found. The actual number of fatalities is greater because not all carcasses are found by searchers and because scavengers remove carcasses.

Studies done in the Midwest and eastern United States in tilled agriculture, grassland, and forested settings are somewhat relevant to the Lempster Mountain project because they involve many of the same species migrate over both sites. These include some hawks, many songbirds,

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some waterfowl, and other bird species. At the ~400 turbine Buffalo Ridge wind power facility near Lake Benton, Minnesota, relatively small numbers of fatalities have been reported (Johnson et al. 2002) during four years of searching at subsets of the turbines. The fatality rates per turbine ranged between about 1 bird per turbine per year to nearly 4.5 birds per turbine per year. The species composition included a variety of birds, including one raptor (Red-tailed Hawk), a very few waterbirds, and migrating songbirds (about 70% of the 53 documented fatalities). Only about 5 ducks and coots were found during the study, despite their regular presence around the wind power site and the fact that the wind plant is on a major migration area for waterfowl (Bellrose 1976).

During two years of carcass searches in the Kewaunee County peninsula of Wisconsin about two-dozen songbird (mostly migrants) fatalities were found under 31 turbines situated in farm fields. Perhaps 6 of the fatalities documented were night migrants. One Mallard and one Herring Gull were the only two waterbirds found dead at this site (Howe et al. 2002). The authors estimated that each turbine killed between 1 and 2 birds per year, when searcher efficiency and carcass removal rates were factored into the estimates. A study of two modern wind turbines at Shirley, WI, revealed 1 night migrating songbird fatality during a year-long study (Howe and Atwater 1999). A study at a small wind plant in Iowa reported no fatalities (Demastes and Trainor 2000).

In the eastern United States and in nearby Canada, fatalities have been examined at 8 wind power facilities. These are most relevant to the Lempster project because they involve many of the same species and migration behaviors, especially among night migrants, and because some of them are in forested habitats. In southeastern Vermont, searches done in June through October 1997 (nesting through migration) revealed no fatalities at 11 new, unlit turbines (192 feet [58 m] tall) situated on a forested hilltop (Kerlinger 2000a and 2002a). Recent searches by the Vermont Agency of Natural Resources using dogs found only 1 dead songbird, verifying conclusions of the earlier study. In upstate New York, several months of daily searches during spring and autumn migration beneath two, unlit wind turbines (168 feet [~51 m] tall) located in open fields revealed no carcasses (Cooper et al. 1995). During a year of study at a wind plant consisting of 7 modern turbines (390 feet [120 m]), all lit with FAA red strobes, in central New York, 4 wind turbine and 1 guyed-meteorology tower fatalities were identified (Kerlinger 2002b). If carcass removal and searcher efficiency rates at this site were similar to those at other projects, the numbers of birds likely be about 2-4+ birds killed per turbine per year. Of these, most would be night migrating songbirds and similar species.

At a facility with 8 modern turbines (4 had red flashing FAA lights) turbines (~280 feet [85 m] tall) located in farmland in Somerset County, Pennsylvania, 17 rounds of fatality searches conducted in June 2000 through May 2001 revealed no avian fatalities (Kerlinger 2001). Subsequent searches of turbines by a Bat Conservation International team using dogs revealed no dead birds. A study by biologists working at 44 turbines (12 were lit with FAA red strobe-like lights) at the Mountaineer Wind Energy Center in West Virginia was conducted in 2003 (Kerns and Kerlinger 2004). The numbers of fatalities at the Mountaineer site (~4+ birds per turbine per year, 2.9 night migrants per turbine per year, 1 duck, and 1 raptor) did not suggest significant biological impacts.

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The greatest fatality rate found for birds at turbines in the United States was about 7 birds per turbine per year found at a 3 turbine forested mountaintop site in eastern Tennessee. The two-year study of the 290 foot (88 m) turbines, which were equipped with white strobes revealed several dozen fatalities, mostly night migrating songbirds (Nicholson 2002). It is ironic that this project was lit with white strobes, the lighting recommended by the U.S. Fish and Wildlife Service as being the least attractive (risky) to night migrants. However, it is likely that the larger rates of fatalities at turbines in Tennessee than farther north are a result of the more southerly latitude of this project as opposed to others in the eastern United States. There are more migrants at more southerly latitudes, thereby increasing potential risk to night migrants.

Two studies in Ontario at one turbine projects reveal similar numbers of fatalities as other eastern wind turbine facilities. The sites are at Exhibition Place in Toronto, on Lake Ontario, and at the Pickering marsh, east of Toronto and not that far inland from Lake Ontario. Neither site reported large numbers of fatalities and at both sites carcass removal and searcher efficiency were studied (James and Coady 2003, James undated).

As summarized above, studies at these and other sites have shown fatalities to be relatively infrequent events at wind turbines. No federally endangered or threatened species have been involved and only occasional raptor, waterfowl, or shorebird fatalities have been documented. In the Midwestern and eastern United States, night migrating songbirds have accounted for a majority of the fatalities at wind turbines. In general, the level of fatalities documented at wind plants have not been large in comparison with the source populations of these species nor have the fatalities suggest biologically significant impacts.

Avian Risk Assessment for the Lempster Mountain Wind Power Project

Disturbance/Displacement/Avoidance Risk at the Lempster Mountain Wind Power Project.

Because most of the habitat within the Project where turbines would be located is forest, there is the potential for habitat impacts, as well as disturbance and displacement of some forest nesting birds. Clearings for wind turbines and roads, as well as other infrastructure, will eliminate and, or modify forested habitat. The result will be a series of small clearings within the forest, each being less than 1 acre, and a road about 50 feet (16+ m) in width. During the clearing and construction process, there will also be impacts to nesting birds on site from the presence of large, loud equipment and human activities.

Actual construction activity will be limited to one year, although maintenance of turbines will be ongoing. The presence of large equipment such as cranes and trucks, the noises from that equipment, and large numbers of people, will undoubtedly disturb and displace birds nesting or foraging in close proximity to the clearing areas. This disturbance will be eliminated for the most part, after the turbines are constructed. This overall activity represents an ephemeral impact. After the heavy construction equipment and large numbers of people leave the site, human activity will be confined mostly to a few people driving small trucks on the road between turbines.

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With respect to longer term forest nesting birds, the habitat altered will fragment existing forests, most of which are only lightly fragmented or unfragmented. This activity may displace some species that currently nest in these habitats. It is not known if the turbines would, in the long term, displace many birds nesting in the forest edges and patches. The degree of impact is most likely related to the size of clearing and the degree to which the forest is allowed to recover following construction of the turbines. If forest clearings are allowed to regenerate, impacts may be very small.

Forest dwelling birds seem to have a greater ability to habituate to tall structures because they live in treed habitats. Kerlinger (2002) found modest disturbance to forest dwelling songbirds at a wind power site in Vermont, although no long term studies of such behavior have been conducted, nor have quantitative studies of displacement distance. It is also possible that some of the more sensitive forest interior nesting species that likely nest on site may be impacted. The habitat on site appears suitable for many of these species.

Small scale clearing and logging in forests similar to those proposed for the wind turbines may not result in significant habitat degradation and fragmentation. Examples in Hodgman and Rosenberg (2000) suggest that even forest interior species that are sensitive to fragmentation are not always impacted by small clearings. Wood Thrushes and Black-throated Blue Warblers showed no ill effects in some studies and some species abundances were actually enhanced by modest forest cutting. However, Blackburnian Warblers have shown negative impacts from even small scale forestry practices. In fact, the Partners In Flight management plan for the New England physiographic region calls for a "shifting mosaic" of forest age, resulting from logging. This is not to be construed as the best option for the Project site, but it is a suggestion that, with planning, the forests on the Project site may be managed to support diverse assemblages of forest interior and sensitive species in the long term, while the turbines continue to produce power.

With respect to edge dwelling species and some brushland inhabiting species, impacts are likely to be minimal or non-existent. The clearing of trees and subsequent brushy undergrowth may actually benefit species such as Chestnut-sided Warblers and Canada Warblers (see references in Hodgman and Rosenberg 2000).

With respect to nesting raptors at the Project site, minor disturbance impacts may occur if turbines are placed near nesting sites of locally nesting species, including Broad-winged and Red-tailed Hawks. It is also possible that Northern Goshawk, Sharp-shinned Hawk, and Cooper's Hawk (New Hampshire threatened) could nest on site, with Sharp-shinned and Broad-winged Hawks being the most likely of these species. The disturbance resulting from actual construction activity is likely to displace nesting raptors if they are within 50-100 m of a nest site. After construction, especially after most construction equipment and workers have left the site, these birds are not likely to be impacted greatly.

Because there are virtually no waterfowl, waterbirds, or shorebirds that frequent the site, there will be no impact to those species.

Although the above analysis examines disturbance and displacement from clearing for turbines, there have been very few studies focusing on if and how forest interior birds habituate

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to the presence of large, moving structures. The study at the Searsburg wind turbines suggests that some of these birds do habituate to the presence of turbine and habituate rapidly. However, no long-term studies have been conducted and only a few forest nesting species have been studied. Because forest interior species are some of the most sensitive, with respect to clearing of forest and recent population declines, a significant research effort is needed to fully elucidate impacts. The Lempster project site is an ideal situation for such study.

The disturbance and displacement impacts that result from the development of 12 to 24 wind turbines on the Lempster Mountain project site cannot be fully understood without more research at forested wind power facilities. Such research would be conducted prior to construction and again after construction at intervals of several years. This would provide an opportunity to determine if forest interior nesting birds and sensitive forest species habituate to the presence of small gaps in the forest canopy and the presence of tall structures.

Collision Risk at Lempster Mountain Wind Power Project.

Endangered and Threatened Species, and Species of Special Concern.

The relative scarcity or absence of federally listed species at the Lempster Mountain site strongly suggests that there will likely be no adverse impacts to those species. Of all listed species, only Bald Eagles (federally threatened) may be present and their presence will likely be small numbers of migrating or dispersing individuals. They will not likely be on site for nesting or foraging activities.

Bald Eagles are not known to be susceptible to colliding with structures such as wind turbines (see species lists in Erickson et al. 2001) or communication towers (see species list in Shire et al. 2000), so it is highly unlikely that adverse impacts to this species will occur.

With respect to state listed species, it is possible that Cooper's Hawk nests on site because the habitat on site appears to be suitable to marginally suitable. However, this species has not been demonstrated to be susceptible to colliding with wind turbines. State endangered species that might fly over the site during migration include Golden Eagle, Peregrine Falcon, and Northern Harrier. State threatened species that may migrate over the site include Cooper's Hawk and Osprey. Also, several of the other New Hampshire listed species could migrate over the site. However, individuals of these species migrating over the site could be from nonlisted populations in Canada or Maine.

Raptors.

Risk to raptors at the Project site is not likely to be biologically significant. Use of the airspace over Lempster Mountain and the project site is likely to be rather limited with few soaring raptors hunting the site on a regular basis. Raptors will be virtually absent between mid-November and mid-March, nearly 5 months of the year. Nesting species likely present include Red-tailed Hawk, Broad-winged Hawk, Sharp-shinned Hawk, and perhaps one or two others. These species are not likely to be present in winter. This is unlike in the APWRA of California where there are hundreds of raptors present amongst the turbines year-round.

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Raptors appear to migrate over Lempster Mountain in small numbers. Risk to migrating raptors, however, has not been demonstrated to be large or biologically significant. At the Mountaineer Wind Energy Facility on Backbone Mountain in West Virginia, a long, linear ridge, a study by Kerns and Kerlinger (2004) showed that the risk to migrating raptors was not great or likely to be biologically significant. Only 1 raptor, a Red-tailed Hawk, was killed during a year of study there suggesting that migrating hawks are not susceptible to colliding with turbines, unlike hunting raptors in the APWRA of California. Also, information from Tarifa in Spain suggests strongly that migrating raptors rarely collide with turbines (see above for details regarding Tarifa fatalities). These sites have many more migrating raptors than would the Lempster Mountain site and more turbines, suggesting that raptor fatality rates at Lempster Mountain are likely to be very low and not biologically significant.

Risk to Night Migrating Birds.

Night migrating songbirds and other small night migrants comprise a majority of birds killed at wind power projects, although the absolute numbers of migrants involved has not been large. Studies summarized in Appendix III have not reported large or significant numbers of night migrants colliding with turbines. The incidents reported involve mostly single birds killed by a turbine on a given night, unlike the large-scale events documented for the past 60 years at communication towers greater than 500-600 feet (152-183 m) in height (Avery et al. 1980). That nocturnal migrants collide at a lower rate with wind turbines as opposed to tall communication towers is related to the much greater height of communication towers, as well as the presence of guy wires (Kerlinger 2000c), and steady-burning FAA red lights (L-810 obstruction lights) on wind turbines. A majority of night migrants fly at altitudes between 300 and 2,500 feet (91-915 m) AGL (Able 1980, Kerlinger 1995, Kerlinger and Moore 1989), with small numbers flying above 5,000 feet (1,524 m) AGL. Except for landing and taking off, fewer migrants are below about 500-600 feet (152-183 m) AGL than above this height range. Mean hourly altitudes usually average about 1,200 to 1,500 feet (366-457 m) AGL (Able 1970). Because the rotors of most modern turbines extend to about 300-390 feet (91-119 m) AGL, small numbers of migrants passing over a site like the Lempster site likely fly within the height range of turbine rotors. The Lempster turbines would be slightly taller than those situated on Appalachian ridges in West Virginia (Kerns and Kerlinger 2004) and Tennessee (Nicholson 2002), which have not been demonstrated to present significant risk to night migrants.

The communication towers that are responsible for a vast majority of avian fatalities, including virtually all of those where large numbers were killed in a single night, are almost entirely taller than 500-600 feet (152-183 m; from literature and recent unpublished studies) in height, much taller than the turbines proposed for the Lempster project. The most recent literature surveys conducted by U.S. Fish and Wildlife and the U.S. Department of Energy (Trapp 1998, Kerlinger 2000b, Kerlinger 2000c) reveal virtually no large scale mortality events at communication towers less than 500-600 feet in height. It should be noted that the few communication towers less than 500 feet in height that have been reported to be responsible for large-scale fatality events have been equipped with steady burning sodium vapor lights or other bright lights (Kerlinger 2004a,b). These lights are very different from the lights stipulated by the FAA and are far more attractive to birds

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The fact that there are no guy wires on turbines is of critical importance, because it is the guy wires of tall communication towers that account for almost all of the collisions. The literature does not reveal fatalities at unguyed communication towers that are as tall as 475 feet and the literature, with a very few exceptions (J. Gehring, Central Michigan University, unpublished study of communication towers in Michigan). Recently, studies at 400-475 foot tall unguyed communication towers revealed between about 0 and 2 birds killed per tower per year, although those results are preliminary. No other studies have revealed collision fatalities at unguyed towers, including unguyed meteorology towers at wind power sites (W. Erickson personal communication, Kerns and Kerlinger 2004).

The last risk factor that has been implicated in collisions of night migrating birds with tall structures is lighting (Kerlinger 2000c). The lights of communication towers and some other structures have been demonstrated to attract migrants that then collide with the structure. The lighting on wind turbines is very different from the lighting on communication towers (FAA Advisory Circular). Wind turbines never (1 exception – a few turbines at Buffalo Ridge in MN have this lighting) have the steady-burning red lights (FAA – L-810 obstruction lights) that are present on communication towers. Note that on the 1,000 foot tall communication towers where large fatality events have occurred, all have been equipped with up to 12 steady burning red L-810 obstruction lights as well as flashing L-864 red lights. Kerns and Kerlinger (2004) demonstrated that there were no large-scale fatality events at wind turbines and that there was no difference in numbers of fatalities at lit vs. unlit turbines. Similar results from wind plants in Washington, Oregon, and Minnesota have supported this finding. Kerns and Kerlinger (2004) did find a fatality event involving about 30 night migrating songbirds in May 2003. That event occurred on a very foggy night and it occurred at an electrical substation involving mostly 1 turbine and the substation fencing. Birds were apparently attracted to 4 sodium vapor lamps on the substation and collided with the three closest turbines (mostly the closest turbine) and the substation infrastructure. Interestingly, almost no birds were found at the 41 other turbines at that project, despite 11 of them being lit with red flashing, L-864 lights. A lesser fatality event, involving 14 migrants at two adjacent turbines in Minnesota is also of interest. Seven birds were found at each of these turbines and one was equipped with steady burning red lights. This suggests attraction by the steady burning red lights.

The fact that no large scale fatality events involving night migrating birds have occurred at wind turbines anywhere, combined with the fact that there is no difference between the numbers of birds killed at lit vs unlit wind turbines at sites across the United States strongly suggests FAA obstruction lighting for wind turbines does not have the same attractive effect as do the steady burning red lights of communication towers (Kerlinger 2004a, b). Furthermore, the FAA does not stipulate that all wind turbines be lit.

For the reasons presented above, collision risk to night migrating songbirds is likely to be minimal and fatalities are not likely to be biologically significant.

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Risk to Shorebirds.

Collision risk to shorebirds is not likely to be biologically significant because few shorebirds collide with wind turbines (Erickson et al. 2001) or communication towers (Shire et al. 2000). They are also not known to be attracted to lights (FAA or other types). Use of the Project site by shorebirds would appear to be nonexistent, although some of these birds probably migrate over the site, mostly at night and at high altitudes (Kerlinger and Moore 1989). Therefore, they are not likely to be at risk of colliding with turbines on site.

Risk to Waterfowl and Waterbirds.

Nesting waterbirds (waterfowl, long-legged waders, shorebirds, rails, etc.) at the Project site are nonexistent, so impacts to these birds appear to be nil. There is no habitat for these species on site. Risk of collision during winter and migration is also likely to be minimal because these birds will not be present in winter and because they migrate at such high altitudes (Kerlinger and Moore 1989, Bellrose 1976). Also, these species have not demonstrated a propensity to collide with wind turbines (or communication towers; Erickson et al. 2001, studies in Appendix III, Shire et al. 2000).

Risk Conclusions

There is the potential for forest nesting birds to be displaced or disturbed by both the construction activity and the presence of large wind turbines on site. Such impacts also include fragmentation and habitat alteration. Because the impacts to forest interior nesting birds from wind turbine construction has yet to be thoroughly studied, the impacts to these birds cannot be entirely assessed. Also, without information on the numbers and types of these birds nesting on site, risk assessment is more difficult. The information available from the Lempster Mountain site and from the literature on collision risk to birds at wind power facilities, would appear to be sufficient to assess potential collision risk to most species of birds at the Project site. There is little likelihood of biologically significant levels of collisions, although agencies such as the U.S. Fish and Wildlife Service are requesting multi-year studies using remote sensing and other methods to better evaluate collision risk.

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Findings

The following conclusions were based on habitat and topography present at the Lempster Mountain Wind Power Project site and from the literature search.

1. Land ownership on the Project site is private and land use on site would continue relatively unchanged (forestry and recreation) following construction of turbines.

2. The Lempster project site is almost entirely forested mountaintop and hills, with a few patches of open ground resulting from mountaintop balds, logging, and some open field maintenance.

3. Mountaintop stands of red spruce are rather large and contiguous. The remaining forests are northern hardwood and mixed conifer stands.

4. The habitat, especially at the higher elevations appears to be high quality forest nesting habitat for songbirds and songbird-like species.

5. There is no suitable habitat on site for nesting by federal or state listed species, with the possible exception of Cooper's Hawk (New Hampshire threatened). However, there are likely to be interior nesting forest songbird species and Partners In Flight priority species, some of which are sensitive to forest fragmentation.

6. Significant migration of hawks, songbirds, waterfowl, shorebirds, or other species is not known or likely to occur over the Project site, although small numbers of hawks do migrate along the mountain during fall. The site does not have ecological magnets that attract large numbers of migrants, but it is likely to host modest numbers of upland bird migrants making stopovers.

7. The habitat on site suggests minimal use by wintering birds and no use by state or federally listed species during this season.

8. The site is not near designated Important Bird Areas; Nature Conservancy preserves; Audubon sanctuaries; or federal parks, refuges, or forests. There are state forests and parks within about 2 miles (3.2 km) of the Project boundary.

9. The Project may displace some forest interior nesting songbird species, although the impacts are not likely to be regionally or globally significant. Fragmentation may result in smaller numbers of some species, while benefiting other species.

10. It is not known if the forest interior nesting species would habituate to the presence of turbines. Recommendations are made to prevent and mitigate these potential impacts.

11. Fatality numbers and species impacted at the Lempster project are likely to be similar to those found at existing wind power projects in the Midwestern and eastern United States and are not likely to be biologically significant.

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Recommendations

The following recommendations are made. They are based on what was found with respect to habitat on the Lempster site and literature/database searches regarding the avifauna of the Project area, as well as what is known about the potential risks to birds from wind power development in the United States and Europe on birds.

- Electrical lines within the project site should be underground between the turbines and any new above ground lines from the site and substations to transmission lines, should follow APLIC (Avian Power Line Interaction Committee) guidelines to reduce the potential for electrocution.

- Permanent meteorology towers should be free-standing and unguyed to minimize the potential for avian collisions.

- Size of roads and turbine pads should be minimal to disturb as little habitat as possible. After construction, forested habitat should be permitted to regenerate as close to turbines and roads as possible to minimize habitat fragmentation and displacement impacts to nesting birds.

- Lighting of turbines and other infrastructure (turbines, substations, buildings) should be minimal to reduce the potential for attracting night migrating songbirds and similar species. FAA lighting for night use, if needed, should be red or white flashing, strobe-like or strobe lights with the longest off cycle permissible. No steady burning FAA lights should be used and sodium vapor lamps, spotlights, and other lights should not be used onsite at night except for emergency maintenance or personnel safety.

- Because the forests on site appear to be suitable for forest interior species that are sensitive to fragmentation, a pre- and post-construction breeding bird studies should be done to determine the degree of displacement of nesting birds, the impacts of forest fragmentation to these birds, and whether or not interior forest nesting birds habituate to the presence of wind turbines. An impact gradient study design is recommended. That research design should be peer reviewed or reviewed by the state or federal wildlife agency to insure it is robust and will measure impacts accurately.

- A post-construction study of collision fatalities would be helpful to future wind power development in New England and New Hampshire, where there is only one utility-scale wind power facility currently operating. Such a study would provide information on the number and type of fatalities that occur, and determine the biological significance of the fatalities documented.

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Figure 1. Map showing location of Lempster Mountain Wind Power Project, Sullivan County, New Hampshire.

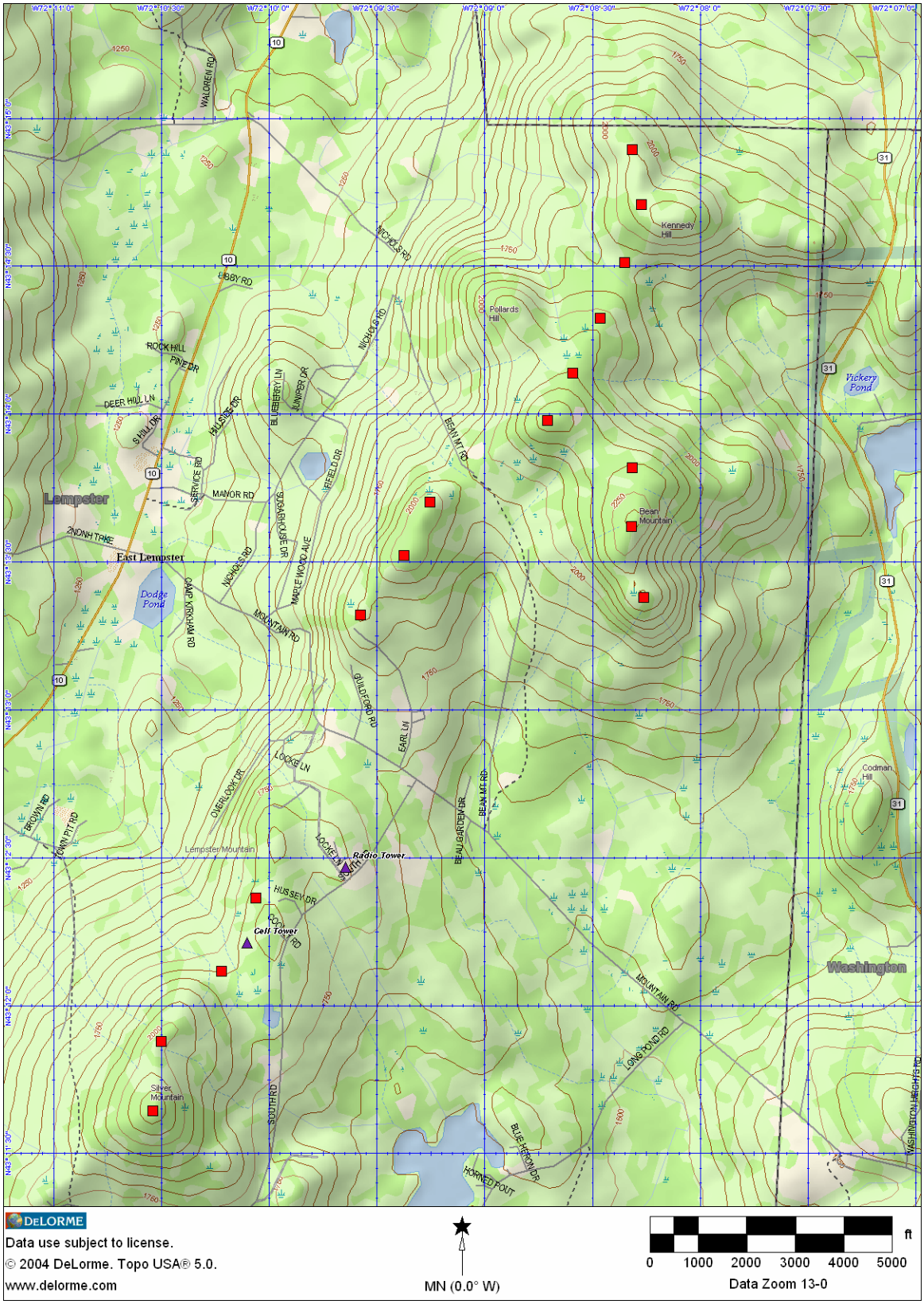

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Figure 2. Photographs showing representative habitat at the Lempster Mountain Wind Power Project, Sullivan County, New Hampshire. Top photo is wide shot of general habitat on the mountain; bottom shot is closeup of dense spruce forest (September 2004).

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Figure 2. Photographs of habitat at the Lempster Mountain Wind Power Project, Sullivan County, New Hampshire. Top photo is a shot of bald on top of Kennedy Mountain with dense spruce at edge of bald; bottom shot is secondary forest (September 2004).

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Appendix I. Conformance with U.S. Fish and Wildlife Service "Interim" and "Voluntary" Guidance and Recommendations for Wind Power Development Document (U.S. Fish and Wildlife Service 2003).

This addendum is written as a response to the recent issuance of the U.S. Fish and Wildlife Service's "interim" and "voluntary" guidance for siting and development of wind power projects. The guidelines appeared in the Federal Register in early July 2003, and the U.S. Fish and Wildlife Service gave a briefing on the new guidance and recommendations to the National Wind Coordinating Committee on July 29, 2003. The guidance are interim and that the Federal Register has opened the comment period, which will last for 2 years. The guideline document has yet to be reviewed, nor has the Service made changes based on public comment during the past year. In April 2004, Director Williams of the U.S. Fish and Wildlife Service sent a letter to state offices of the Service in which he made directives and suggestions regarding the implementation of the guidance and recommendations document.

The risk assessment conducted for the Lempster project relied on procedures similar to those presented in the Service's guidelines, as well as others that exceed what is usually requested by the Service. The standard Phase I Avian Risk Assessment process incorporates a large number of the guidelines and recommendations made by the Service, particularly those that have been shown to be scientifically valid. Therefore, the risk assessment presented above fulfills the intent of the guidance and recommendations document to avoid or minimize impacts to wildlife, specifically birds, and their habitats.

Conformance to Guidelines – Specifics

Teaming With Agencies. Letters were sent to the U.S. Fish and Wildlife Service's (USFWS) New England office and the New Hampshire Fish and Game Department requesting information on listed species and species of special concern, as well as other bird information. A meeting was held by developers on April 8, 2005 with USFWS, New Hampshire Fish and Game, New Hampshire Department of Environmental Services to outline the project and begin discussion of avian issues. Approaching these agencies meets the recommendation by the Service that developers should attempt to team or involve such agencies in the process. There does not appear to be a federal nexus for the Lempster project, although the New Hampshire Fish and Game Department may be involved through the state process. It is possible that if work within wetlands is required for roads or turbine locations, a federal nexus will occur through the U.S. Army Corps of Engineers who often defer to the USFWS with respect to wildlife issues.

Reference Site. The Lempster Mountain Wind Power site was compared to other wind power facilities in the United States, including about 10 existing wind power projects in the Midwest and east, as well as projects in the western United States and Europe. Selecting a worst-case scenario site for comparison with the project site was not possible because choosing such sites would necessitate tenuous assumptions about high risk at wind power projects that have not been demonstrated. Selection of a worst-case scenario site at this time would not be based on biologically documented impacts. None of the other wind power projects in the United States, with the possible exception of the APWRA of California have resulted in biologically significant impacts to birds. In this respect, comparisons were made and they suggest that risk at the

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Lempster site is no greater than at other wind power facilities in the United States, in terms of collision risk to birds.

Although it was not possible to compare the Lempster project with a site that could be construed as a worst case scenario site, comparisons to the APWRA and sites where risk has been documented to be negligible were made. Clearly, the Lempster project site does not have the collision risk factors present in the APWRA. Further comparisons were made to the impacts of communication towers of various sizes, lighting specifications, and construction types (guyed vs. unguyed). This type of comparison is particularly important because there is a large body of research on communication towers, including towers in the eastern and Midwestern United States.

Determination of potential biological significance of documented fatalities at wind power facilities (including the probable number of fatalities at the Lempster site) with the numbers of fatalities permitted by the USFWS via depredation, hunting, and falconry permits does not suggest that impacts of wind turbines are biologically significant. Those comparisons are relevant because they provide actual numbers of takings that the USFWS deem to be biologically not significant.

With respect to habitat disturbance and displacement of nesting birds, comparisons were made with various sites where such disturbance has been determined to occur. Because these types of impacts are likely to occur among some forest interior nesting species at the Lempster project site, further research has been recommended to prevent and, or mitigate such impacts. Such research combined with postconstruction evaluation would be extremely important toward understanding the overall impacts of wind turbines with respect to northeastern forest nesting bird communities.

Alternate Sites. An analysis of alternative sites was problematic. No alternative sites were available for this study. It should also be noted, however, that if no federal permits (NEPA) are necessary for this project, an alternative sites analysis is not required. The Phase I Risk Assessment however, did compare potential impacts at the Lempster project to other wind power projects.

Checklists. Instead of using the PII and checklists supplied in the Service's guidelines, the Phase I assessment included detailed descriptions of the habitat and topography of the site and surrounding areas. For example, the risk assessment included determination of actual or potential migration pathways, the presence of ecological magnets and, or other attractive habitats are located within or adjacent to the Project boundary. This included descriptions of the forests other habitat on site, degree of existing habitat fragmentation (or lack thereof), degree of landscape alteration by logging and other land use practices within and around the site that could influence avian impacts potentially resulting from the proposed development.

- Conformance to Service Recommendations
    - Site Development – The Phase I Avian Risk Assessment covers the following concerns voiced in the USFWS's guidance and recommendations document.

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- Letters of inquiry were sent to the USFWS and New Hampshire Department of Fish and Game) soliciting records of listed species. Also, habitat was examined to determine whether listed avian species are likely to nest or use the site.
- The Lempster site is not on a known migration pathway for hawks, songbirds, shorebirds, waterfowl or other migrants. However, it should be noted that, wind turbines have not been suggested or demonstrated to have biologically significant impacts on these birds. This was explained in detail in the report.
- Raptor use of the area appears to be moderate, so setbacks from soaring/updraft locations do not seem to be applicable. Raptor fatalities at wind power projects outside of the 5,400 turbine APWRA have totaled very few birds, which has not been suggested to be biologically significant. It should be noted that none of the turbines would be at the edge of steep terrain which could be used for soaring.
- Configuring turbines in ways that would avoid potential mortality has not been demonstrated empirically to reduce or prevent impact, a result of fatality numbers being small at existing wind power facilities.
- Habitat fragmentation issues have been addressed in the risk assessment.
- There are no prairie grouse or similar species present. Forest nesting species or constellations of species that may be disturbed or displaced were addressed in the Phase I assessment.
- Road areas and habitat restoration are addressed in the risk assessment.
- Carrion availability is not applicable at the Project site.

o Wind Turbine Design and Operation – Many of the Service's recommendations were either made in the risk assessment or are routinely done at modern wind plants. Some Service recommendations are incorrect or not applicable.

- Tubular (unguyed) towers will be used to prevent perching.
- Permanent meteorology towers have been recommended to be free-standing, without guy wires, in the risk assessment.
- The Service's recommendation that "only white strobes should be used at night" to avoid attracting night migrants is only partially correct. That red lights should be avoided is also only partially correct. There is strong evidence (Kerlinger 2004a, 2004b) that red strobe-like FAA lights, in the absence of steady burning red L-810 lights, do not attract birds to wind turbines. Red strobe-like lights (L-864) are likely to be recommended by FAA. This has been addressed in detail in the text of this risk assessment.
- Adjustment of tower/rotor height is problematic and cannot be addressed in this report.
- Underground electric lines and APLIC guidelines have been recommended in the risk assessment.
- Seasonal concentrations of birds are addressed in the risk assessment. The appropriateness of shutting down turbines or other mitigation is dependent on the level of demonstrated impacts, which cannot be determined preconstruction.

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- The Service's guidance document stipulates that radar or other remote sensing methodologies should be used if large concentrations of migrants are suspected. There is no scientific reason to suspect that there will be a large or significant concentration of migrants at the Project site, so radar or other remote sensing is not indicated.
- Post-construction fatality monitoring would provide a means of determining the impact the project has to birds and was recommended in the risk assessment.

Overall, the USFWS's interim and voluntary guidance document promises to provide a means of evaluating wind power sites for wildlife impacts. Some of the guidance and recommendations are integral to adequately assessing risk, although some have not been substantiated or are only partially correct. The guidance and recommendations document is in need of a thorough review from the scientific community, industry, and environmental organizations prior to being required for wind power projects. Most importantly, there is need for validation of the recommendations and the protocols for ranking a site as to potential risk. Until such validation has been done, it is difficult to determine how valuable the guidance and recommendations document is. (The American Wind Energy Association [AWEA] has reviewed the USFWS' guidelines and recommendations and in December 2003, detailed that review in a letter to Interior Secretary Norton. The USFWS has stated they will not address comments or revise their guidelines and recommendations until mid-2005.)

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Appendix II. Letters from New Hampshire Fish and Game Department and the U.S. Fish and Wildlife Service in response to inquiries for information regarding endangered and threatened, species at or near the Lempster Mountain Wind Power Project, Sullivan County, New Hampshire.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New England Field Office
70 Commercial Street, Suite 300
Concord, New Hampshire 03301-5087

RE: Lempster Mountain Wind Farm
Sullivan County, NH

October 29, 2004

Michael Curry
Curry & Kerlinger, L.L.C.
P.O. Box 453
Cape May Point, New Jersey 08212

Dear Mr. Curry.

I have reviewed your request for information on endangered and threatened species and their habitats for the above-referenced project. My comments are provided in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543).

Based on information currently available to us, no federally-listed or proposed, threatened or endangered species or critical habitat under the jurisdiction of the U.S. Fish and Wildlife Service are known to occur in the project area. However, some threatened and endangered species, such as the bald eagle and the Indiana bat, are migratory and their seasonal movements are not well known. At this time, we are unaware of any recent, documented records of endangered Indiana bats east of the Green Mountains in Vermont. While there is a potential for bald eagles to occur in the project area, the nature of their presence is probably irregular and transitory. Without site-specific information on bald eagle migration for the project area, we cannot provide more specific information at this time.

Thank you for your cooperation, and please contact me at 603-223-2541, extension 23, if we can be of further assistance.

Sincerely yours,

Michael J. Amaral

Michael J. Amaral
Endangered Species Specialist
New England Field Office

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New Hampshire
Fish and Game Department

11 Hazen Drive, Concord, NH 03301-6500
Headquarters: (603) 271-3421
Web site: www.wildlife.state.nh.us

TDD Access: Relay NH 1-800-735-2964
Fax (603) 271-1438
E-mail: info@wildlife.state.nh.us

Lee E. Perry
Executive Director

October 18, 2004

Michael Curry
Curry & Kerlinger, L.L.C.
PO Box 453
Cape May Point NJ 08212

RE: NHFG file 2004-0684, Lempster Mountain Wind Project

Dear Mr. Curry:

The NH Fish and Game Nongame and Endangered Wildlife program has reviewed your request for information regarding state-listed species near the proposed Lempster Mountain wind project. We have no known locations of state listed species found within the boundary of the project. However, there is high potential for impacts to a variety of wildlife species under the proposed project. Although we have not documented the presence of endangered species at the proposed impact location, this area has not been sampled for rare species to our knowledge.

Of major concern are the potential effects on migratory birds and bats. U.S. Fish and Wildlife Service has authority over impacts to migratory birds through the Migratory Bird Treaty Act of 1918 and the NHFG has authority under the Endangered Species Conservation Act (RSA 212A). Several bats of conservation concern could be potentially found in areas surrounding the proposed impact including Eastern red bat, Hoary bat, Silver-haired bat, Eastern pipistrelle and the state endangered small-footed bat. Other species that may occur in the general area include bobcat, state-threatened pine marten and possibly three-toed woodpeckers.

In addition to direct impacts to migratory birds and bats, we have concerns over the habitat loss and fragmentation that would occur as a result of clearing and construction of access roads. Wide ranging mammals may be particularly vulnerable to these fragmentation features, including marten, bobcat, bear, and moose.

We look forward to meeting with you and the U.S. Fish and Wildlife Service regarding this issue. Please contact me at 603-271-3016 for further details.

Conserving New Hampshire's wildlife and their habitats since 1865.

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Sincerely,

Michael Marchand
Nongame & Endangered Wildlife Program

Cc: Michael Bartlett, U.S. Fish and Wildlife Service
Bill Ingham, NH Fish and Game Ecologist

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Appendix III. Review of avian studies in the United States. The numbers provided below have, in most cases, are numbers of observed fatalities. The actual numbers of fatalities, when observer efficiency and carcass removal by scavengers are included, are greater than the numbers provided.

- **Vermont** – Searsburg near Green Mountain National Forest, 11 modern turbines in forested mountain top, nesting and migration season, 0 fatalities, Kerlinger 2002

- **New York** - Tug Hill Plateau, 2 modern turbines in farmland, 2 migration seasons, 0 fatalities, Cooper et al. 1995

- **New York** – Madison, 7 modern turbines on farmland, 1 year, 4 fatalities (2 songbird migrants, 1 owl, 1 woodpecker), Kerlinger 2002

- **Pennsylvania** – Garrett (Somerset County), 8 modern turbines, farm fields, 12 months, 0 fatalities, Kerlinger 2001

- **West Virginia** – Mountaineer WEC, 44 modern turbines on forested ridge, 1 year study (22 searches of all turbines), 69 fatalities found, 200+ fatalities (4+ fatalities per turbine per year; mostly night migrating songbirds, 1 Red-tailed Hawk), Kerns and Kerlinger 2004

- **Tennessee** – Buffalo Mountain, 3 turbines on forested/strip mined mountain, 2 years, ~7 fatalities per turbine per year (night migrating song and other birds), Nicholson 2001, 2002

- **Massachusetts** - Hull, 1 modern turbine, open grassy fields adjacent to school and ferry terminal on island in Boston Harbor, informal searches for at least 1 year on dozens of occasions revealed no fatalities – Malcolm Brown, personal communication, 2002

- **Minnesota** – Buffalo Ridge near Lake Benton, 200+ of modern turbines in farm and grassland, 4 years (1996-1999), 53 fatalities found, 2-4 fatalities per turbine per year (mostly songbirds and 1 hawk); displacement found among grassland nesting songbirds; Johnson et al. 2002

- **Kansas** – St. Mary's, 2 modern turbines in grassland prairie, 2 migration seasons; 33 surveys, 0 fatalities, Young 1999

- **Wisconsin** – Kewaunee County Peninsula, 31 modern turbines in farmland, 2 years (4 migration seasons), 25 fatalities, ~1.3 fatalities per turbine per year, (3 waterfowl, 14 songbirds, some night migrants), Howe et al. 2002

- **Wisconsin** – Shirley, 2 modern turbines in farmland, 54 surveys, 1 fatality (night migrating songbird), report to Wisconsin Department of Natural Resources Bureau of Integrated Science Services and Richter Museum of Natural History Special Report, Howe and Atwater 1999

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- **Iowa** – Algona, 3 modern turbines in farmland, three seasons, 1 year, 0 fatalities, Demastes & Trainer 2000

- **Iowa** – Top of Iowa, 89 turbines in farm fields (26 studied), 1 year, 2 fatalities (songbirds), Koford et al. 2004

- **Colorado** – Ponnequin, 29 (44 in 2001) modern turbines in rangeland, 5 years - 1999-2003, ~ 2 dozen birds per year, 1 duck, 1 American Kestrel fatality, Curry & Kerlinger unpublished data

- **Wyoming** – Foote Creek Rim, 69 modern turbines in rangeland, 2 years, 75 turbine fatalities (songbirds – 48% night migrants - and 4 raptors), 1.8 fatalities per turbine per year, Young et al. 2003 (15 additional fatalities were at guyed meteorology towers)

- **Oregon** – Klondike, 16 modern turbines in rangeland and shrub-steppe, 1 year, 8 fatalities found (songbirds – ½ night migrants, 2 Canada Geese), 1.3 fatalities per turbine per year, Johnson et al. 2003

- **Oregon** – Vansycle, 38 modern turbines in farm and rangeland, 1 year, 11 birds (7 songbirds [~ 4 night migrants], 4 gamebirds, Erickson et al. 2000

- **Oregon-Washington** – Stateline Project, 1.5 years, 106 fatalities including 7 raptors (28+ bird species total) at 124 or 399 modern turbines in farmland, 1.7 fatalities per turbine per year, 1.0 fatalities per turbine per year, Erickson et al. 2003

- **Washington** – Nine Canyons – 37 modern turbines, 1 year, prairie and farmland, 36 bird fatalities found (mostly songbirds, 1 kestrel, 1 Short-eared Owl), 3.6 fatalities per turbine per year, Erickson 2003

- **California** - Altamont Pass Wind Resource Area (APWRA), 5,400 older turbines mostly on lattice towers in grazing and tilled land, many years, large numbers of raptor fatalities (>400 reported) and some other birds, Howell and DiDonato,1991, Howell 1997, Orloff and Flannery 1992, 1996, Kerlinger and Curry 1997, Thelander and Rugge 2000

- **California** – Montezuma Hills, 237 older turbines, 11 modern turbines in tilled farmland, 2+ years, 30+ fatalities found (10 raptors, 2 songbirds, 1 duck), Howell 1997

- **California** – Montezuma Hills – High Winds, 90 modern turbines in tilled farm and grazing land, 103 fatalities including raptors (1 Golden Eagle), 1st year of 3 year study, unpublished report to High Winds Technical Advisory Committee (including US Fish and Wildlife)

- **California** - San Gorgonio Pass Wind Resource Area, thousands of older turbines, 120 studied in desert, 2 years, 30 fatalities (9 waterfowl, 2 raptors, 4 songbirds, etc.), Anderson et al. 2000

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- **California** - Tehachapi Pass Wind Resource Area, thousands of turbines, 100s of mostly older turbines studied, in Mojave Desert mountains (grazing grassland and scrub), 2+ years, 84 fatalities (raptors, songbirds), Orloff 1992, Anderson et al. 2000

Canada

- **Ontario** – Pickering Wind Turbine, 1 modern turbine (384 feet, 117 m) near a marsh, 2 migration seasons, 2 nocturnal migrant fatalities (James unpublished report)

- **Ontario** – Exhibition Place, 1 modern turbine in Toronto on the lakefront, 2 migration seasons, 1 starling and 1 American Robin fatality; projected 3 birds per year (James and Coady 2003)

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