# Section 7
# Wetlands, Wildlife, and Fisheries

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## 1.0 PROJECT DESCRIPTION

Evergreen Wind Power II, LLC (Evergreen II) has proposed an amendment to the Oakfield Wind Project (project) in Oakfield and T4R3 WELS, Maine (Figure 1). This application by Evergreen II addresses the changes to the generating facilities, and a companion amendment application by Maine GenLead, LLC, addresses the new generator lead. This amendment revises the Oakfield Wind Project as follows:

- change the approved turbines in the original project area from 34 General Electric (GE) 1.5-megawatt (MW) with a 77-meter rotor diameter and an 80 meter tower, to 25 Vestas V-112 3.0-MW turbines, with a 112-meter rotor diameter and an 84-meter tower;
- add temporary and permanent meteorological (met) tower locations;
- change turbine pad size, turbine locations, road widths, and some road locations;
- eliminate the northern substation;
- add 25 Vestas V-112 3.0-MW turbines in new project areas;
- add a new substation location; and
- change the point of electrical interconnection.

The project area as presented in the amendment includes the locations of proposed wind turbines and access roads required for construction and operation of the project. The amendment includes design changes in the original project area that are evaluated in other sections of this application (ex. increase number of turbines; pad size changed). There are no changes to wetland, wildlife or fisheries resource impacts within the original project area (see Section 7 of L-24572-24-A-N). Therefore, this report evaluates resources and potential impacts only within the new (additional) project area.

In advance of permitting activities for the project, Evergreen II contracted Stantec Consulting (Stantec) to conduct wildlife surveys, wetland delineations, rare, threatened, and endangered (RTE) plant species surveys, and vernal pool surveys within the project area to determine the presence of natural communities and any incidental wildlife species observations. The surveys provide data to help assess the potential risk to natural resources associated with the proposed project. The scope of these surveys was based on a combination of standard methods and is consistent with surveys conducted for other wind developments in Maine and throughout the Northeastern United States.

To the extent practicable, the project will be designed to reduce impacts to local wildlife (e.g., by maximizing use of the existing road network on the ridges and minimizing lighting on the turbines). Additionally, the project design will include the avoidance (to the extent practicable) of regulated resources such as wetlands and streams, or areas such as extremely steep slopes.

A review of available natural resource information in the area and ecological field investigations was conducted to characterize the habitats and wildlife use of the proposed project area. This information helps characterize the habitats present, identify predominant wildlife use, characterize some of the more critical resource concerns typically associated with wind energy developments, and address any site-specific concerns for the project.

Information used to characterize the existing wildlife communities and their habitats included consultation with state and federal agencies and review of available wildlife habitat databases and published natural resource classification systems. Additionally, a variety of site-specific field surveys were conducted from 2007 through 2011 that included:

- Bat detector surveys in the fall of 2007 and the spring and summer of 2008;
- Nocturnal songbird migration surveys using radar in the spring and fall of 2008;
- Daytime raptor migration surveys in the spring and fall of 2008;
- Eagle aerial nest flight surveys in 2009 and 2010, as well as eagle activity surveys in summer and fall of 2009, and winter, spring and fall of 2010; and
- Wetland, vernal pool, and vegetation surveys in the spring, summer, and fall of 2008-09; and spring of 2010 and 2011.

Stantec also consulted with natural resource agencies, including the Maine Department of Conservation Natural Areas Program (MNAP), the Maine Department of Inland Fisheries and Wildlife (MDIFW), Maine Department of Environmental Protection (MDEP), and the U.S. Fish and Wildlife Service (USFWS), to determine if there are any documented occurrences of RTE species or natural communities within or in the vicinity of the project area.

Available databases of ecological resources and classification systems that were used during this characterization and assessment included the Database of Essential Habitats and Sensitive Natural Areas, as categorized by the MDIFW (http://megisims.state.me.us); Land Use Regulation Commission Land Use Maps (http://www.state.me.us/doc/lurc); Natural Landscapes of Maine: A Guide to Natural Communities and Ecosystems (Gawler and Cutko 2010); and Biophysical Regions of Maine (McMahon 1990).

The following sections outline the regional and local landscape setting, the dominant vegetation types and wildlife species, and the significant natural resources that occur in vicinity of the project area. In addition, this report addresses potential impacts to natural resources and wildlife that may result from the proposed project. With regard to wetland, stream and vernal pool resources, this amendment presents those resources specifically within the expanded project area. Some of these resources were included in the original Oakfield Wind Project application and have been assigned a new identification code for the amendment. The *Delineated Natural Resource Maps* focus principally on those resources within the new project area. In those instances where the *Delineated Natural Resource Maps* overlap with the original Oakfield Wind Project area, those delineated resources within the original project area are uniquely symbolized to differentiate between the previous and current project areas.

## 2.0 PROJECT AREA CONTEXT

The project is located within the Aroostook Hills Region and Aroostook Lowlands Region of Maine as originally described by McMahon (1990). The 15 biophysical regions described by McMahon (1990) were based upon areas demonstrating similar physiography, climate, surfical geology and soils, and plant species/communities. These 15 biophysical regions were consolidated for the Maine's Comprehensive Wildlife Conservation Strategy (MDIFW 2005) into 8 ecoregions. Based upon this consolidation, the project is located within the Aroostook Hills and Lowlands Ecoregion. This ecoregion is an area of approximately 2.5 million acres characterized by calcareous soils and a predominance of bedrock in the hills, while deep loams provide the basis for a large agricultural land use in the lowlands. It represents the transition from temperate northern forests to the boreal spruce-fir forests that occur to the north and throughout Canada. The Aroostook Hills portion of the ecoregion is characterized by gently rolling hills with elevations averaging between 800 and 1,000 feet (McMahon 1990). The topography of the Aroostook Lowlands portion of the ecoregion is relatively low, with an average elevation between 600 and 800 feet with some isolated, higher monadnocks (bedrock hills). The Aroostook Lowlands area contains some of the most extensive calcareous formations in the Maine. Aroostook Hills and Lowlands Ecoregion is sparsely populated when compared to southern Maine. Much of the land area is in commercial timber production with extensive agricultural land occurring in the Aroostook Lowlands. This ecoregion also includes significant areas of freshwater wetlands dominated by aquatic bed habitat and peatlands. Major waterways in the area include Higgins Brook, Morrison Brook, Center Line Brook, East Branch of the Mattawamkeag River, Nickerson Brook, Shingle Brook, Owl Pond Brook, and Skitacook Stream. Major waterbodies in the area include Pleasant Lake, Skitacook Lake, Mud Lake, and Drews Lake (Meduxnekeag Lake). These waterbodies have a network of associated brooks, streams, and wetlands that ultimately feed the Penobscot River watershed.

Within the project area, the principal land use is commercial forestry. Although some portions of this area have not been harvested for several decades, most have been harvested several times within the last 75 years. No areas of completely undisturbed, old growth forest were observed. Roads within the project area include a network of existing logging roads and all-terrain vehicle/snowmobile trails. Some of these roads are used to access private lots located within the project area. Several roads provide access to the ridge, but most require four-wheel drive and are not considered thru-roads. Other uses surrounding the

project area include agriculture, recreational boating, hunting, fishing, and snowmobiling. Several seasonal camps occur within and adjacent to the project area, and there are year-round residencies at the lower elevations.

The land cover surrounding the project area is predominantly hardwood forest, especially on upland ridges and hilltops. Areas of deciduous-coniferous mixed forest occur infrequently in lowlands and at lower elevations on the upland ridges. A variation of the naturally occurring Beech–Birch–Maple Forest (Gawler and Cutko 2010) is the dominant forest community within the project area. This type of Northern Hardwood Forest occurs in rich to semi-rich soils, often on well developed loams and typically with a closed canopy in natural conditions. It includes a combination of American beech (*Fagus grandifolia*), yellow birch (*Betula alleghaniensis*), and sugar maple (*Acer saccharum*). The percent coverage of the dominant canopy species varies along the ridgelines as a result of differing land management practices. A variation of the Spruce–Northern Hardwoods Forest community also occurs in the project area. Dominant canopy trees include American beech, sugar maple, red spruce (*Picea rubens*), and yellow birch, with hop-hornbeam (*Ostrya virginiana*) and paper birch (*Betula papyrifera*) as canopy associates. Examples of this community variation occur along the northern and southern ridgeline of the Oakfield Hills.

The ridges are largely upland hardwood forest and early successional forest. Both short and long-term forest management practices have influenced the natural communities present within the project area. There are no MNAP-listed critically imperiled or imperiled natural communities within the project area; however, MNAP did note the presence of an exemplary Beech-Birch-Maple Forest community located on Hunt Ridge. Additionally, one MDIFW-mapped Significant Wildlife Habitat occurs within the project area along South Oakfield Road. Wetlands within the summit of the project area are relatively few in number and are classified as palustrine (freshwater, non-tidal) emergent, scrub-shrub, or forested wetlands. Many of these wetlands have experienced some level of anthropogenic alteration, principally changes associated with timber harvesting activities. Several wetlands include natural depressions or basins that hold water seasonally, and some serve as breeding sites for vernal pool-associated species. The existing land cover types and specific observations within the project area are described in more detail in the following sections.

Soils in the project area are generally mesic and well-drained. The Aroostook County Soil Survey (USDA 1964) indicates that the Thorndike Series is common and occurs over the majority of the project area, particularly along the ridgelines as Thorndike shaly silt loam and Thorndike very rocky silt loam. In general, the Thorndike series is no more than 20 inches deep and is mainly present in the forested landscape. Shale fragments (non-calcareous) and granite bedrock outcroppings are present below and at the surface. The Howland Series, generally a well-drained soil, is also present along the ridges in the project area. The Monarda and Burnham Series, a poorly drained soil, is also mapped within the project area, although to a lesser degree than the Thorndike and the Howland Series. A detailed description of the soils within the Project area is included in Section 11 of this application.

## 3.0 EXISTING VEGETATION TYPES

The project area is characterized primarily by upland hardwood forest. The existing land cover types influence the wildlife communities present in the project area. Climate conditions, geology, and past and recent land uses (i.e., forest harvesting and agriculture) affect the type and structure of available wildlife habitats. The ridges consist predominantly of deep, well-drained soils on flat to moderate slopes, mainly gravelly silt loams at higher elevations, with varying degrees of rockiness and stoniness. The lower elevations consist of moderately to somewhat poorly drained silt loams. Wetland resources are uncommon along most of the ridgeline areas where development is proposed. Many of the wetlands that occur on the ridge areas have been altered by past forest management activities. Perennial and intermittent streams are present in lowland areas between hilltops and along hillsides. Small areas of mixed conifer-deciduous forest or conifer-dominated forest occur sporadically, largely on the steepest north-facing slopes or in wetlands.

Because the project layout is designed to avoid wetlands to the greatest extent possible, the proposed turbines are sited in upland hardwood forested areas. Natural community features present within the study area include Beech-Birch-Maple Forest, Spruce-Northern Hardwood forest, Hardwood Seepage Forest and the Red Maple Sensitive Fern Swamp (Gawler and Cutko 2010). Following are descriptions of the natural communities that occur within the project area and that could be potentially impacted by the proposed project.

### 3.1. UPLAND HARDWOOD FOREST

Upland forested habitats within the project area largely fall within the Spruce-Fir-Northern Hardwoods Forest Ecosystem. This is a very common, widespread ecosystem throughout most of northern Maine (Gawler and Cutko 2010). A variety of forested natural communities can occur within this ecosystem but only one, Beech-Birch-Maple Forest, dominates the project area.

Within the Beech-Birch-Maple Forest, common tree species include American beech, paper birch, yellow birch, sugar maple, striped maple (*Acer pensylvanicum*), and red maple (*Acer rubrum*). White ash (*Fraxinus americana*) and American linden (*Tilia americana*) are also locally common, and northern red oak (*Quercus rubra*) and hop-hornbeam are occasional canopy associates. Canopy closure is variable in some areas and depends on the intensity of forest harvesting practices that have occurred in the last 5-10 years. Young regenerating stands are composed almost entirely of sapling-sized canopy species, often thick stands of sugar maple. If unaltered by harvesting, the canopy is often closed, resulting in a shaded forest floor with limited herbaceous and shrub development. Common herbaceous species include Dutchman's breeches (*Dicentra cucullaria*), spring beauty (*Claytonia caroliniana*), round-leaved violet (*Viola rotundifolia*), fibrous-rooted sedge (*Carex communis* var. *communis*), drooping wood sedge (*Carex arctata*), oak fern (*Gymnocarpium dryopteris*), red wakerobin (*Trillium erectum*) and wild sarsaparilla (*Aralia nudicaulis*).

In response to a request for information, MNAP noted that there is an exemplary Beech-Birch-Maple Forest present on Hunt Ridge in the Project area. MNAP provided a map that showed two distinct communities in the area adjacent to where wind turbines and access roads are proposed for construction (see Appendix 7-1 for complete MNAP response). Based on field surveys performed by Stantec, the smaller natural community polygon (the eastern polygon) has been extensively cut in recent years and now consists of a regenerating Beech-Birch-Maple forest. This area would not be considered an exemplary natural community. The southern portion of the larger natural community polygon (the western polygon) has also been largely cut over in recent years and is no longer representative of a true Beech-Birch-Maple forest. The northern portion of this polygon, however, is relatively uncut and is fairly representative of a true Beech-Birch-Maple forest. Canopy trees in this area range from 14 to 32 inches diameter at breast height (DBH), with the majority in the 18 to 22-inch range. The herbaceous layer is well developed here and is dominated by ferns, particularly evergreen wood fern (*Dryopteris intermedia*) accompanied by oak fern, marginal wood fern (*Dryopteris marginalis*), and New York fern (*Parathelypteris novaboracensis*), and the previously mentioned herbaceous species. For a discussion of impacts, avoidance, and minimization efforts to this community, refer to Section 9 of this permit application.

Areas with tree canopies altered by forest harvesting (i.e., open canopies) occur across the project area, with most occurring in the eastern portions of the project area. These areas typically have a canopy closure of 60 percent or less, which is atypical of this hardwood forest community. Due to the openness of the canopy, the understory in these areas is more robust than undisturbed versions and includes a shrub layer of dominant tree species such as red maple, yellow birch, sugar maple, and American beech. Common hardwood forest understory shrubs include beaked hazelnut (*Corylus cornuta*), striped maple, hobblebush (*Viburnum lantanoides*), and highbush-cranberry (*Viburnum opulus* var. *americanum*), as well as early successional species such as red raspberry (*Rubus idaeus*), blackberry (*Rubus allegheniensis*), and several goldenrod species, most commonly Canada goldenrod (*Solidago canadensis*).

Several small pockets of Spruce-Northern Hardwoods Forest exist throughout the project area. These pockets are typically very small (i.e., less than 5-10 acres in size) and occur on steep slopes and areas with shallow soils. Canopy trees in this community type are typically 14 to 18 inches DBH. Shrub and

herbaceous layer development is sparse and includes seedlings of canopy species, as well as wild sarsaparilla, northern wood sorrel (*Oxalis montana*), three-leaved goldthread (*Coptis trifolia*), painted wakerobin (*Trillium undulatum*) and starflower (*Trientalis borealis*). The bryophyte layer is typically well developed and dominated by three-lobed bazzania (*Bazzania trilobata*).

Early successional habitat occurs mainly in the central and eastern portion of the project area in locations that have been previously disturbed, including along road and trail edges and sites of intense forest management. Most of the forest harvesting that has recently occurred has included heavy selection cutting rather than clear-cutting. Consequently, the harvested areas, while containing habitat features typical of early successional habitats such as dense shrubs and saplings, still have an intact, although open, canopy.

A few areas in the central portion of the project area have recently had complete canopy removal and are characterized by early successional shrubs, saplings, and wildflowers. Species common to these areas include pin cherry (*Prunus pensylvanica*), quaking poplar (*Populus tremuloides*), red raspberry, bristly blackberry (*Rubus hispidus*), whorled aster (*Oclemena acuminata*), Canada goldenrod, large sweet grass (*Anthoxanthum odoratum*), ox-eye daisy (*Leucanthemum vulgare*), and common wrinkle-leaved goldenrod (*Solidago rugosa*). In these areas, the understory species that prefer a closed canopy appear to be under physiological stress with yellowing and withering leaves and distorted growth habits.

### 3.2. WETLANDS

Stantec completed wetland delineations within the project area in 2008, 2009, 2010 and 2011 (refer to Appendix 7-1). During this time, Stantec documented emergent wetlands, wet meadows, streams, scrub-shrub wetlands, vernal pools, and forested wetlands (Cowardin *et. al* 1979). The project is designed to avoid and minimize impacts to those resources (see Table 7-1). These impacts are detailed in Appendix 7-2. Throughout the project area, Stantec identified the following:

- A total of 158 wetland resources along the ridges, proposed access roads and the electrical collector line;
- 58 jurisdictional streams, 43 of which are perennial;
- 46 vernal pools and 6 Significant Vernal Pools; and
- 50 wetlands that meet criteria to be considered *Wetlands of Special Significance*.

Many of the forested wetlands on-site contain intermittent or lower perennial streams. Plant species composition along these streams includes American beech, sugar maple, red maple, yellow birch, American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), and hop-hornbeam. The shrub layer contains the same species present in the tree layer, as well as beaked hazelnut and speckled alder (*Alnus incana* ssp. *rugosa*). The herbaceous layer contains water carpet (*Chrysosplenium americanum*), sensitive fern (*Onoclea sensibilis*), cinnamon fern (*Osmunda cinnamomea*), oak fern, spotted touch-me-not (*Impatiens capensis*), and sedges (*Carex* spp.), most often fringed sedge (*Carex crinita*), nodding sedge (*Carex gynandra*), awl-fruited sedge (*Carex stipata* var. *stipata*), and eastern rough sedge (*Carex scabrata*). Eastern rough sedge in particular often forms extensive patches at the edges of streams and in adjacent wetlands. Stream sides with greater amounts of alluvial deposition and/or associated calcareous substrates support silvery glade fern (*Deparia acrostichoides*), zig-zag goldenrod (*Solidago flexicaulis*), fiddlehead fern (*Matteuccia struthiopteris* ssp. *pensylvanica*), and occasional specimens of rattlesnake fern (*Botryichium virginianum*) and narrow triangle moonwort (*Botrychium angustisegmentum*).

**Table 7-1. Wetland and Stream Impact Summary – New Project Area**

| Wetland Impacts | Permanent fill (sq. ft.) | Temporary fill (mats, sq. ft.) | Vegetation clearing (sq. ft.) | Stream impact--- Culvert (lin. ft.) |
|---|---|---|---|---|
| Turbine Pads | - | - | - | - |
| Summit roads | 10,572 | - | 18,094 | 383 |
| Electrical Collector System | 360 | 25,929 | 156,166 | - |
| **TOTAL** | **10,932** | **25,929** | **174,260** | **383** |

### 3.2.1. Forested Wetlands

Forested wetlands are present throughout the project area. Forested wetlands are those with more than 30 percent of their area dominated by woody vegetation that is greater than 3 inches in diameter and 20 feet in height. Canopy cover may consist of deciduous species, evergreen species, or a combination of the two. The on-site forested wetlands are characterized largely as Hardwood Seepage Forests and Red Maple Sensitive Fern Swamps. These occur in low depressions and side slopes where groundwater discharges to the ground surface. Red maple is the dominant tree species, with yellow birch, black ash (*Fraxinus nigra*), and green ash also present. While the understory in these areas contains few shrubs, speckled alder and highbush cranberry occur in areas that are more open due to disturbance. Herbaceous species include sensitive fern, various sedges (*Carex gynandra, Carex scabrata* and *Carex vulpinoidea*), common woolsedge (*Scirpus cyperinus*), various grasses (*Glyceria melicaria, Glyceria canadensis, and Calamagrostis canadensis*), and dwarf raspberry (*Rubus pubescens*). Eastern rough sedge is often dominant in the Hardwood Seepage Forest community. Soils in these wetlands vary from more than 16 inches of organic material (a histosol) to 3-12 inches of organic and/or a dark A horizon over a depleted matrix with redoximorphic features. Forested wetlands occur primarily at the lower topographic positions on the landscape and appear to have been undisturbed for several decades.

Some forested uplands have been more recently altered by timber harvesting resulting in tree removal, soil compaction, and the creation of open areas of standing or ponded water. These areas are most appropriately characterized as man-made wetlands. They are characterized by compacted soil from the action of heavy equipment, which has created an impermeable layer and intercepted the groundwater that, under natural conditions, occurs a foot or more below the ground surface. Trees present in these disturbed habitats include species typically associated with upland habitat such as quaking poplar, paper birch, and American beech, as well as species more typically associated with wetlands such as red maple and yellow birch. The sparse shrub layer includes species in the tree stratum, occurring as saplings, as well as red raspberry, speckled alder, pussy willow (*Salix discolor*), long-beaked willow (*Salix bebbiana*), and bristly blackberry. Herbaceous species include sensitive fern, common wool-sedge, spotted-touch-me-not, common wrinkle-leaved goldenrod, common soft rush (*Juncus effusus*), and sedge species, typically fringed sedge and nodding sedge (*Carex gynandra*).

### 3.2.2. Scrub-Shrub Wetlands

Scrub-shrub wetlands are found throughout the project area. Scrub-shrub wetlands occur as either formerly forested wetlands that are reverting following timber harvesting or as naturally occurring shrub dominated communities such as Alder Shrub Thickets. Most of the on-site scrub-shrub wetlands are the former, made up of species such as speckled alder, white meadowsweet (*Spiraea alba* var. *latifolia*), yellow birch, gray birch (*Betula populifolia*), black ash, green ash, high-bush cranberry, northern white cedar (*Thuja occidentalis*), balsam fir (*Abies balsamea*), red-osier dogwood (*Swida* [*Cornus*] *sericea*), long-beaked willow, highbush blueberry (*Vaccinium corymbosum*), and pussy willow. The herbaceous layer is often lush and composed of sensitive fern, nodding sedge, fringed sedge, awl-fruited sedge, various grasses (typically a species of (*Glyceria*), Pennsylvania bitter-cress (*Cardamine pensylvanica*),

Canada goldenrod, common wrinkle-leaved goldenrod, and cinnamon fern. Soils in these wetlands are variable, ranging from histosols to areas with a depleted B horizon.

#### 3.2.3. Emergent Wetlands

Many of the wetlands within the project area are characterized as emergent wetlands. Some of these emergent wetlands are naturally occurring communities, whereas others have been altered by natural or anthropogenic activities. These altered emergent communities are often referred to as wet meadows and are represented in the project area by formerly forested wetlands that are in the very early stages of succession following timber harvesting or by meadows that developed above abandoned beaver (*Castor canadensis*) dams. In some cases, these are emergent communities that are part of larger wetland complexes containing other wetland types. An emergent wetland is defined as having more than 30 percent of its area dominated by herbaceous plants such as sedges, grasses, rushes, ferns and other forbs. Wet meadows are dominated by herbaceous species that are adapted to saturated soil conditions but are not adapted to long periods of inundations as would be common in marsh habitats. The on-site emergent wetlands typically contain cinnamon fern, common soft rush, common wool-sedge, mosquito bulrush (*Scirpus hattorianus*), grass-leaved goldenrod (*Euthamia graminifolia*), northeastern mannagrass (*Glyceria melicaria*), fowl mannagrass (*Glyceria striata*), nodding sedge, fox sedge (*Carex vulpinoidea*), rough sedge, necklace sedge (*Carex projecta*), northern willow-herb (*Epilobium ciliatum*), purple-stemmed American-aster (*Symphyotrichum puniceum* var. *puniceum*), tall white-aster (*Doellingeria umbellata* var. *umbellata*), water carpet (*Chrysosplenium americanum*), three-petaled bedstraw (*Galium triflorum*), and sensitive fern. Soils are moderately deep in these areas, with organic soil material over a depleted matrix with redoximorphic features. Some of these areas have been disturbed, and the emergent species are the first to re-colonize.

#### 3.2.4. Streams

Stantec identified 58 MDEP-jurisdictional streams throughout the project area. Both perennial and intermittent streams occur and are differentiated by the estimated time they flow throughout the year. Intermittent streams flow for only part of the year, while perennial streams flow year-round under normal conditions. The majority of the streams in the project area are associated with forested wetlands, with only a few lacking associated wetland resources. The most common types of aquatic vegetation found within these stream channels are aquatic mosses (*Fontinalis sp*.), and in some instances, water carpet in the slower flowing sections of the channel. The most common aquatic wildlife observed in the stream channel was a variety of caddisfly species (*O: Trichoptera*) in the form of larval cases attached to the bottom of rocks. Black-fly (*O: Diptera F: Simuliidae*) and stone fly (*O: Plecoptera F: Taeniopterygidae*) larvae were also observed under rocks, and small predatory fish were observed where there was sufficient water in the channel.

#### 3.2.5. Vernal Pools

Stantec conducted vernal pool surveys within the project area in spring of 2008, 2009, 2010 and 2011. Stantec identified a total of 46 vernal pools within the project area, 6 of which are Significant Vernal Pools. The results of these surveys are provided in Appendix 7-1. The pools were located in a variety of wetland habitats, ranging from disturbed, emergent wetlands (e.g., skidder ruts) to naturally occurring forested wetlands. These areas provide important breeding habitat for amphibian and invertebrate species.

### 3.3. Rare Plants

Field surveys completed by Stantec in 2008 and 2009 within the original project area documented several populations of large toothwort (*Cardamine maxima*), as well as a population of Goldie's fern (*Dryopteris goldiana*). Both are listed as Species of Special Concern by MNAP. In response to the known occurrences of RTE plants and an exemplary natural community, Stantec ecologists and botanists completed RTE plant surveys and natural community evaluations in 2009 and 2010 throughout the present project area. These surveys targeted large toothwort and Goldie's fern, as well as other RTE

plant species and an exemplary natural community that are known from the surrounding region. Stantec identified three additional locations of large toothwort within the Project area. These additional locations occurred in an upland area along the electrical collection corridor and at the base of two side slopes alongside a proposed road. The population will likely respond favorably to the edge habitat opening created by the road, provided that its habitat is not directly disturbed. The population of Goldie's fern was not observed during the 2010 surveys due to recent forest harvesting activity. This population is not expected to recur until the canopy redevelops and the forest matures.

## 4.0 WILDLIFE USE OF THE OAKFIELD PROJECT AREA

The presence of wildlife species is correlated with the type of land cover in a given area. Following are brief descriptions of the wildlife species known or suspected to occur in the Project area. A list of wildlife species observed within the project area (Appendix 7-3) was derived from observations documented during extensive field surveys along the ridges during fall 2007; spring, summer, fall, 2008; spring, summer, fall 2009; and winter and spring 2010. In addition, species-specific surveys were conducted at various locations in the project area as part of the pre-construction surveys for the original project, including investigations of nocturnal migrants, diurnal raptor migration and eagle activity surveys, and bat detector surveys. Because of the proximity of the original and current project areas, MDIFW indicated that the previous surveys were sufficient to characterize activity in the new project area, and concluded that no additional pre-construction surveys were needed (Refer to correspondence from Richard Hoppe, MDIFW, to Joy Prescott, Stantec, dated March 26, 2009). The results of these surveys are summarized in this section, and full details have been prepared in separate reports included as Appendices 7-4 to 7-8.

### 4.1. SIGNIFICANT WILDLIFE HABITATS AND SPECIES

Significant or sensitive wildlife habitats are protected under state and/or federal law. As defined in Chapter 335 of the NRPA, Significant Wildlife Habitat potentially present in the vicinity of the project area includes:[1]

- Habitat for state and federally listed endangered and threatened species;
- Mapped high and moderate value deer wintering areas (DWAs) and travel corridors;
- Mapped high and moderate value inland waterfowl and wading bird habitats (IWWHs), including nesting and feeding areas; and
- Significant Vernal Pools.

Stantec contacted natural resource agencies such as MDEP, MNAP, MDIFW, and USFWS to determine if there are any documented occurrences of RTE species or natural communities within or in the vicinity of the project area. Complete agency responses are presented in Appendix 7-1.

A response from MDEP stated that there are mapped wetland and streams in the project area, along with mapped IWWH. MDEP suggested that wetland and vernal pool surveys should be performed to more accurately map these resources. According to MDIFW, there are no Essential Habitats known to occur within the proposed project area. However, MDIFW noted that an occurrence of the state threatened brook floater mussel (*Alasmidonta varicosa*) has been documented in the East Branch of the Mattawamkeag River, west of the project area. MDIFW also noted the presence of mapped IWWH in the vicinity of the project. A response from USFWS indicated that the project is located within the range of the Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon (*Salmo salar*), as well as within the potential habitat of Canada lynx (*Lynx canadensis*), and that bald eagles (*Haliaeetus leucocephalus*) may be present in the general project area.

Additional information about each of these resources is further discussed in the following sections.

[1] Based primarily on the project location and the results of the agency contacts, the project area will not impact Significant Wildlife Habitat located in coastal or tidal areas, such as shorebird habitat, seabird habitat, or mapped Tidal Waterfowl and Wading Bird Habitat. Only those habitats which are known to occur at inland locations were reviewed for this project.

### 4.1.1. Habitat for State Listed Species

No habitat for state-listed threatened or endangered wildlife species was identified by MDIFW or documented during field surveys.

### 4.1.2. Habitat for Federally Listed Species

Critical Habitat for Atlantic Salmon

In 2009, Critical Habitat was designated for the freshwater geographic ranged occupied by the GOM DPS of Atlantic salmon, including all perennial stream, river, and lake habitats connected to the marine environment (50CFR226: Federal Register, June 19, 2009). The Project area is located within this designated Critical Habitat, specifically the East Branch of the Mattawamkeag River watershed (HUC 10 102000302). The Project layout includes 227 linear feet of perennial stream impact at three locations. (see Figures 4, 15, 19 of Appendix 7-2).

Canada Lynx

In 2009, the Critical Habitat was designated for Canada Lynx in portions of northern Maine (50CFR17: Federal Register, February 25, 2009). Although the Project area is not within Critical Habitat, it does fall within the lynx range as mapped by the USFWS. In Maine, lynx have been shown to be strongly correlated with young forest stands, including conifer-dominated sapling stands and deciduous-dominated sapling stands for feeding, as well as mature conifer stands for travel. These young regenerating stands frequently support the highest densities of snowshoe hare (*Lepus americanus*), the principal food source for lynx (Vashon *et al* 2008). At the request of USFWS, Stantec conducted a town-wide habitat assessment of potential lynx habitat during informal consultation for the original project. Stantec's landscape assessment principally focused on identifying young regenerating forests within the vicinity of the project area through the use of both high resolution digital aerial photographs and stereo pairs of aerial photographs viewed through a stereoscope. Stantec also used existing on-the-ground knowledge of the forest stand conditions from previous field surveys to augment the aerial photography analysis. This assessment determined that in the Town of Oakfield, there is little regenerating softwood habitat within or near the project area, and the size and distribution of patches of potential habitat in the Project area are not sufficient to support a lynx home range. Stantec also conducted a habitat assessment of potential lynx habitat in T4R3 and determined there is a mosaic of approximately 1,212 acres of regenerating softwood in the southeastern quadrant of T4R3, approximately 1.3 miles south of the project area, and smaller stands are scattered throughout the western half of T4R3. Within T4R3, the ridges are largely mid-successional hardwood-dominated with scattered spruce and fir, and even with future harvests, these areas are unlikely to develop optimal snowshoe hare habitat conditions.

Because of the limited availability of suitable lynx habitat within or within the immediate vicinity of the project area, the project is unlikely to adversely affect the present habitat availability and movement of Canada lynx across the landscape. Studies in Maine have demonstrated that lynx populations are strongly correlated with young regenerating forest stands and that they may avoid maturing deciduous stands within their home ranges. The dominance of mature and mid-successional deciduous and mixed forests within the Project area does not represent preferred habitat for the Canada lynx. In addition, the interstate highway, which forms the eastern boundary of the mapped Critical Habitat, could present a partial barrier to lynx movements into Oakfield from adjacent towns to the north and west.

Bald Eagle

In 2009, the bald eagle was removed from Maine's list of species identified as state endangered or state threatened and designated as a Species of Special Concern. Although no longer listed by the federal Endangered Species Act, it is protected by the federal Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Stantec conducted three aerial eagle nest surveys in the Project area: one in 2009 and two in 2010. Based upon these surveys, there was one bald eagle nest site located within four miles of proposed turbine locations. This nest site, located on Meduxnekeag Lake (Drews Lake), was active in spring 2009, but inactive in spring 2010. No alternative nest site was found on Drews Lake during the spring 2010 survey. At the time of the submission of this application, 2011 bald eagle nest

surveys are on-going. Information on eagle activity in the Project area was documented during three years of surveys from 2008 to 2010. Overall, during 88 days (693 hours) of survey over three years, 32 observations of bald eagles were documented, resulting in an overall bald eagle passage rate of 0.04 eagles/hour within the Project area (Appendix 7-8).

#### 4.1.3 Deer Wintering Areas

Based on a review of MDIFW data, no DWAs are located within the Project area and no impacts to these resources are expected with the project.

#### 4.1.4 Inland Waterfowl and Wading Bird Habitat

The landscape surrounding the Project area includes several wetlands that have been mapped by MDIFW as IWWH. One IWWH is located to the west of the project area along the East Branch of the Mattawamkeag River, one IWWH is located north of the project area along Drews Lake (Meduxnekeag Lake), and two IWWH's are associated with Skitacook Lake and Mud Lake on the east-central side of the project area (Figure 2). The northern tip of IWWH #131086 (associated with Skitacook Lake and Mud Lake) overlaps with the project area at South Oakfield Road. No impacts to wetlands associated with the IWWH are expected since South Oakfield Road is an existing road, and no improvements are anticipated in this area.

### 4.2. BIRDS

Specific avian surveys for the project included raptor migration surveys and eagle use surveys. Incidental observations of birds were made during other natural resource surveys conducted within the Project area. A variety of bird species are known or suspected to occur within the Project area, including species common to northern hardwood forests and open upland shrub habitat. Bird species that often utilize upland hardwood forests and that were observed in the project area include black-capped chickadee (*Parus atricapillus*), blue jay (*Cyanocitta cristata*), golden-crowned kinglet (*Regulus satrapa*), hairy woodpecker (*Picoides villosus*), downy woodpecker (*Picoides pubescens*), ruffed grouse (*Bonasa umbellus*), winter wren (*Troglodytes troglodytes*), hermit thrush (*Catharus guttatus*), red-eyed vireo (*Vireo olivaceus*), ovenbird (*Seiurus aurocapillus*), yellow-rumped warbler (*Dendroica coronata*), black-throated blue warbler (*D. caerulescens*), black-and-white warbler (*Mniotilta varia*), black-throated blue warbler (*Dendroica caerulescens*), barred owl (*Strix varia*), northern goshawk (*Accipiter gentilis*), broad-winged hawk (*Buteo platypterus*), and red-tailed hawk (*Buteo jamaicensis*). Many other species of songbirds may use the habitats presented though only during migration periods.

The occasional pockets of spruce forest distributed along the ridgeline provide a different habitat for breeding songbirds, and some species may focus their use in those areas. Species that utilize this habitat and that were observed in the project area include northern parula (*Parula americana*), black-throated green warbler (*Dendroica virens*), ruby-crowned kinglet (*Regulus calendula*) and black-backed woodpecker (*Picoides arcticus*).

Open areas dominated by early successional habitats are suitable for a number birds that nest or forage in these regenerating habitats. Common species that use this habitat and that were observed in the project area include northern flicker (*Colaptes auratus*), American robin (*Turdus migratorius*), chestnut-sided warbler (*Dendroica pensylvanica*), common yellowthroat (*Geothlypis trichas*), chipping sparrow (*Spizella passerine*), white-throated sparrow (*Zonotrichia albicolis*), dark-eyed junco (*Junco hyemalis*), veery (Catharus fuscescens), and rose-breasted grosbeak (*Pheucticus ludovicianus*). Red-tailed hawks regularly hunt from perches in this habitat.

Wetland habitats near the southern half of the project area may receive use by a subset of species that specialize in these habitats, including swamp sparrow (*Melospiza georgiana*), American bittern (*Botaurus lentiginosus*) and yellow warbler (*Dendroica petechia*).

Stantec performed diurnal raptor surveys to characterize raptor migration activity. Surveys were conducted from the summit of Sam Drew for 12 days in spring 2008 and 12 days in fall 2008. In spring and summer 2008, there was a total of 58 individual observations of 7 different species, yielding an overall passage rate of 0.7 raptors/observation-hour. In fall, a total of 60 individual observations of 8 different species yielded an overall passage rate of 0.7 raptors/observation-hour. This observation rate was low for both years as compared to similar sites in the region. For further details and the complete Diurnal Raptor Survey results, refer to Spring 2008 Bird and Bat Migration Survey Report and Fall 2008 Bird Migration Survey Report in Appendices 7-5 and 7-6, as well as the Addendum in Appendix 7-7.

Of the avian species incidentally observed in the project area or observed during raptor migration surveys, none were state-listed as threatened or endangered. There were several species listed as Species of Special Concern. These included the bald eagle, evening grosbeak, white-throated sparrow, black-and-white warbler, chestnut-sided warbler, and veery.

As part of the pre-construction surveys for the original project, Stantec conducted radar surveys in the spring and fall of 2008 to monitor nocturnal migrants (song birds and bats) passing over the project site. Surveys were conducted using X-band marine radar, sampling from sunset to sunrise. Each hour of sampling included recording radar video files during horizontal and vertical operation. The radar site was located at the summit of Sam Drew Mountain and provided unobstructed views nearly 360 degrees around the radar site. The spring 2008 survey included 20 nights of sampling between May 1 and June 3, and the fall 2008 field survey included 20 nights of sampling from August 28 to October 11.

In spring, the overall passage rate for the entire survey period was 498 targets per kilometer per hour (t/km/hr) with a seasonal average mean flight height of all targets of approximately 276 meters above the radar site, and 26 percent of targets were observed flying below maximum turbine height (Appendix 7-5, Appendix 7-7). In fall, the overall passage rate for the entire survey period was 501 t/km/hr with a seasonal average mean flight height of all targets of 309 meters above the radar site, and 23 percent of targets were observed flying below maximum turbine height (Appendix 7-6, Appendix 7-7). The overall passage rate during both seasons is within the range of those observed at numerous other radar studies conducted in the northeast on forested ridges. For further details and the complete Nocturnal Radar Survey results, refer to Spring 2008 and Fall 2008 Bird and Bat Migration Survey Reports in Appendices 7-5 and 7-6, as well as the Addendum in Appendix 7-7.

### 4.3. MAMMALS

Mammals observed within the Project area include white-tailed deer (*Odocoileus virginianus*), moose (*Alces alces*), coyote (*Canis latrans*), black bear (*Ursus americanus*), snowshoe hare, red squirrel (*Tamiasciurus hudsonicus*), gray squirrel (*Sciurus carolinensis*) and meadow voles (*Microtus pennsylvanicus*). Based upon available habitat, other species likely to be present in the project area include the red fox (*Vulpes vulpes*), bobcat (*Lynx rufus*), marten (*Martes americana*), fisher (*Martes pennanti*), long-tailed weasel (*Mustela frenata*), raccoon (*Procyon lotor*), porcupine (*Erethizon dorsatum*), striped skunk (*Mephitis mephitis*), northern short-tailed shrew (*Blarina brevicauda*), eastern chipmunk (*Tamias striatus*) and southern red-backed vole (*Clethrionomys gapperi*).

Eight species of bats occur in Maine, based upon their normal geographical range. These are the big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), eastern red bat (*Lasiurus borealis*), hoary bat (*L. cinereus*), eastern small-footed myotis (*Myotis leibii*), little brown myotis (*M. lucifugus*), northern myotis, (*M. septentrionalis*), and tri-colored bat (*Perimyotis subflavus*) (BCI 2001). Of these, all except the big brown bat are listed in Maine as Species of Special Concern. As part of the pre-construction surveys for the original project, Stantec conducted acoustic bat detector surveys during the fall of 2007 and the spring and summer of 2008. Acoustic bat detectors allow for long-term monitoring of species composition and activity patterns in a variety of habitats, including the airspace approaching the rotor-swept zone of the turbines. In fall 2007, four detectors were deployed from August 2 to November 1 for a total of 265 detector-nights; detectors were initially deployed in trees, and two detectors were moved to a met tower erected in late September. In spring and summer 2008, six detectors were deployed from

April 25 to August 11, for a total of 565 detector-nights, including deployment in both trees and met towers.

In fall 2007, tree detectors recorded on average 5.1 calls/detector night, and met tower detectors recorded on average no calls/detector night. In spring 2008, tree detectors recorded on average 5.2 calls/detector night, and met tower detectors recorded on average 0.25 calls/detector night. In the summer, tree detectors recorded on average 24.3 calls/detector night, and met tower detectors recorded on average 0.92 calls/detector night. The average detection rates of met tower detectors were similar to average detection rates for other surveys conducted within the region. The average detection rates of tree detectors were within the upper range of other similar surveys conducted in the region and can likely be attributed to peaks in activity at one detector during a two-week period, as well as detector location in potential travel corridors used for foraging.

Bat call sequences were individually marked and categorized by species group, or "guild" based on visual comparison to reference calls. Qualitative visual comparison of recorded call sequences to reference libraries of bat calls allows for relatively accurate identification of bat species (O'Farrell *et al*. 1999, O'Farrell and Gannon 1999). Call sequences were classified to species whenever possible, based on criteria developed from review of reference calls collected by Chris Corben, the developer of the Anabat system, and other bat researchers. However, due to similarity of call signatures between several species, all classified calls have been categorized into the following guilds[2] reflecting the bat community in the region of the project area.

- Unknown (UNKN) – All call sequences with too few pulses (less than five) or of poor quality (such as indistinct pulse characteristics or background static). These calls were further identified as either "high frequency unknown" (HFUN) for calls above 30 kilohertz (kHz0 or "low frequency unknown" (LFUN) for calls below 30kHz.
- Myotid (MYSP) – All bats of the genus *Myotis*. While there are some general characteristics believed to be distinctive for several of the species in this genus, these characteristics do not occur consistently enough for any one species to be relied upon at all times when using Anabat recordings.
- Eastern red bat/ tri-colored bat[3] (RBTB) – Eastern red bats and eastern pipistrelles. These two species can produce calls distinctive only to each species. However, significant overlap in the call pulse shape, frequency range, and slope can also occur.
- Big brown/silver-haired/hoary bat (BBSHHB) – This guild will be referred to as the big brown guild. These species' call signatures commonly overlap and have therefore been included as one guild in this report.

Bat calls were identified to the lowest possible taxonomic level and were grouped into four guilds based on their call characteristics. The majority of calls in all three seasons were identified as *Myotis* (65%), followed by unknown calls (34%). Less than one percent of calls were identified as species in the red bat/eastern pipistrelle guild or big brown guild. This trend in species composition is similar to that of other similar studies conducted in the region. For further details and the complete Bat Detector Survey results, refer to Fall 2007 Bat Migration Survey Report, Spring 2008 Bird and Bat Migration Survey Report in Appendices 7-4 and 7-5.

### 4.4. AMPHIBIANS AND REPTILES

There is a predominance of upland hardwood forest in the Project area, which is non-breeding habitat for most amphibians. The canopy of hardwood forests allows more light to reach the forest floor, which can result in higher summer temperatures. Because amphibians generally require cool, moist micro-habitats, their use of upland hardwood forests may be limited. This is especially true in areas where more intense forest management has occurred. Amphibians observed within the project area include wood frog

[2] Gannon *et al.* 2003 categorized bats into guilds based upon similar minimum frequency and call shape. These guilds were: Unidentified, Myotis, LABO-PISU and EPFU-LANO-LACI.
[3] The scientific and common name of the eastern pipistrelle (*Pipistrellus subflavus*) has been changed to the tri-colored bat (*Perimyotis subflavus*).

(*Lithobates sylvatica*), spotted salamander (*Ambystoma maculata*), blue-spotted salamander (*Ambystoma laterale*), green frog (*Lithobates clamitans*), and American toad (*Bufo americanus*). Some other species likely to be present based upon their known range and available habitats include the northern redback salamander (*Plethodon cinereus*), gray treefrog (*Hyla versicolor*), two-lined salamander (*Eurycea bislineata*), and spring peeper (*Pseudacris crucifer*). The proposed project will not significantly alter aquatic resource on the ridges, but it will alter the upland habitat potentially used by several of these species. However, negative impacts to these populations are not expected.

The reptile community within the project area is likely represented predominantly by snakes. The maritime garter snake (*Thamnophis sirtalis pallidula*) was observed the during 2008 wetland delineations. Other species likely to be present include the redbelly snake (*Storeria occipitomaculata*), common garter snake (*Thamnophis sirtalis*), and ringneck snake (*Diadophis punctatus*). The open canopy and dense shrub development across much of the project area likely provides suitable habitat for these species. Turtles are less likely to occur within the project area because of a lack of suitable habitat. Some species, however, do travel considerable distances during nesting. It is possible that some open areas at lower elevations in the project area, such as gravel roadsides, may be used as nesting habitat by snapping turtles (*Chelydra serpentina*) and painted turtles (*Chrysemys picta*) that otherwise inhabit the wetland resources located around the bases of the hills.

Of the amphibians and reptiles observed within the project area, none are listed as threatened or endangered. The diploid populations of the blue-spotted salamander are state listed as Species of Special Concern.[4]

## 4.5. FISHERIES

The project area provides some fisheries habitat, including named streams such as Moose Brook, Center Line Brook and Nickerson Brook. There also are numerous smaller perennial and intermittent streams within the project area (Appendix 7-1, Table D-2). The streams within the project area may support a variety of coldwater fish species, including brook trout, stocked rainbow trout (*Oncorhynchus mykiss*), and stocked brown trout (*Salmo trutta*). Other species include redbelly dace (*Phoximus eos*), creek chub (*Semotilus atromaculatus*), finescale dace (*Phoximus neogaeus*), and shiner (*Nortropis spp.*). The MDIFW indicated the proposed Project will not impact any inland Essential Fish Habitat, but that the East Branch of the Mattawamkeag River, located east of the Project area, supports a limited wild brook trout (*Salvelinus fontinalis*) population that is augmented by hatchery trout in the Oakfield and Smyrna area. The USFWS commented that the entire Penobscot River drainage is part of the Critical Habitat for Atlantic salmon. Streams crossed by the proposed collector line include Moose Brook, Centerline Brook, Nickerson Brook, and an unnamed mapped stream. The applicant has prepared detailed road construction plans to protect surface water quality.

### 4.5.1. Impacts and Effects on Streams and Associated Fisheries

Section 10 of this application details the specific buffer designs intended to minimize impacts to stream resources. Construction techniques for crossing streams are discussed in Section 14. Considering the extent of streams in the landscape and the measures taken to protect the streams from erosion, pollutants and thermal increases, it is not expected that the fisheries resources within the Project area will be adversely impacted.

[4] The hybridization of Jefferson and blue-spotted salamanders resulted in the development of two completely female populations that are all polyploids, (they have multiple sets of chromosomes rather than the normal set of two (diploid)).

## 5.0 EFFECTS ON HABITATS AND ASSOCIATED WILDLIFE

Construction of the proposed project is anticipated to affect local wildlife populations in various ways. Initially, the direct loss of habitat will result from construction of permanent roads and turbine clearings. Potential indirect effects could also include avoidance of the project area by species sensitive to noise and the presence of people and temporary displacement of wildlife until forested habitat redevelops in temporary clearings during and following construction of the project, which could result in short-term avoidance of the area by some species and targeted use of the project area by others. Wind turbines also pose a collision risk to birds and bats.

Changes in cover type will occur when clearings are made for the construction and operation of the wind turbines. The turbine clearings will be approximately 2 acres in size, most of which will be allowed to revegetate as either grassland or low shrubs. In large part, access to the turbine areas will be accomplished using existing roads with some surface upgrades required. In areas where no existing roads are present or use of existing roads is not practical, new road corridors will be cut and cleared. New road segments were designed to avoid impacts to wetlands, vernal pools, and streams where possible. For the most part, clearings made for the collector transmission line will re-vegetate to conditions that resemble regenerating clearcuts that are already common throughout the region.

### 5.1. HABITAT LOSS AND DISTURBANCE

The project was designed to avoid wetlands to the greatest extent possible and, therefore, the proposed turbines and associated access roads will largely occur in upland hardwood forest. Construction will result in the direct loss of forested upland and the conversion of some forested habitat to early-successional habitat.

The development of the project will require the construction of turbine structures, the upgrade of existing roads, the construction of new roads, and the placement of a power collection line adjacent to the road bed. Each turbine will be located in an opening just over two acres in size. This opening will be graded relatively flat and, after construction, much of it will be allowed to revegetate to herbaceous and shrub cover. The road system needed to construct the project will have permanent travel surfaces between 12 and 36 feet wide.

The Beech-Birch-Maple Forest, which is the predominant habitat within the project area, is one of the most common hardwood forest types within the state. Undue impacts to wildlife communities associated with this habitat are not expected. Wildlife that use this area experience frequent changes in the available habitat as the result of timber harvesting and should adapt to many of the changes that will result from the proposed project. There will be some direct loss of habitat, but species are expected to shift their use to similar habitat that is available in the surrounding area. There also likely will be some temporary displacement of species during the actual construction activities, but most species should return to occupy available habitat within the project area.

Several populations of large toothwort were identified within the project area. There is some risk of habitat loss for these species, although observed populations in 2009 and 2010 occurred on the side slopes and most populations are in areas not proposed for development. The one area that may experience loss is the population of large toothwort directly under the electrical collection corridor. This plant responds to openings in the canopy where partial shade remains. This species is locally abundant, so any mortality that may occur in the width of the open corridor will be recouped by the population expanding along the edge of the corridor. Relocation of these plants to the edges of the open corridor may alleviate some loss of individual plants, but the greater landscape of this project area holds many populations similar to this one, and the plants are likely to produce the same result naturally.

### 5.2. DIRECT IMPACTS TO WILDLIFE

The construction and operation of the turbines will result in a permanent change in cover type and habitat in the turbine clearings and along constructed access roads. The majority of the surrounding forest will

remain in its present condition, and no further development is expected in the immediate vicinity of the turbines beyond the current level of forest management activities. Terrestrial wildlife is not expected to be impacted by the operation of the project. Similar to the turbine areas, wildlife use of the collection line may be affected to some degree by a change in cover type and fragmentation. Short-term disturbances will likely occur during construction.

Wind turbines also pose a potential threat to migratory birds and bats. Based on site surveys, operation of the wind turbines in the project area is not expected to pose a significant threat to birds or bats. The radar surveys indicate that passage rates in the project area are comparable to other radar sites in the vicinity. Flight height and flight direction data indicate that the majority of migratory birds are flying at a height sufficient to avoid the proposed turbines and blades. Diurnal raptor surveys indicate that passage rate of raptors is low compared to other sites in the area. Acoustic bat data suggests that the number of bats in the Project area is similar to other sites that area geographically similar. Overall, the project is not located in an area of significant bird and bat migration, and the construction of the project is not expected to significantly impact populations of these species.

Aerial surveys in 2010 indicated that the one bald eagle nest site located within four miles of proposed turbine locations, on Meduxnekeag Lake (Drews Lake), was not active in 2010. Adult bald eagles were observed on the lake, and therefore it is possible that this nest may be active in the future. Additionally, surveys performed at the site, documented bald eagles elsewhere in the Project area. Although direct impacts to bald eagle are unlikely, the applicant will conduct post construction monitoring.

The project is unlikely to adversely affect habitat availability and movement of lynx across the landscape based on the limited availability of suitable lynx habitat within or within the immediate vicinity of the project area. Studies in Maine have demonstrated that lynx populations are strongly correlated with young regenerating forest stands and may avoid maturing deciduous stands within their home ranges for both feeding and movement. The dominance of mature and mid-successional deciduous and mixed forests within the project area suggest that the project area does not provide preferred habitat for lynx. In addition, the interstate highway forms the eastern boundary of the Critical Habitat, which is an anthropogenic feature that could present a partial barrier to lynx movements into Oakfield from adjacent towns to the north and west.

The Project layout includes 227 linear feet of stream impact for three crossings of streams located within the project area designated as Critical Habitat for salmon. One stream, an unnamed tributary of Downing Brook, was evaluated as part of the pre-construction surveys for Oakfield I (see Figure 4, Appendix 7-2). Although suitable habitat for juvenile Atlantic salmon was documented in this stream a section of ledge outcroppings downstream of the proposed road crossing present a cascade that is impassable to juveniles (Appendix 7-3). Suitable habitat for adult Atlantic salmon was not observed in this stream. This stream, and the two other perennial streams, will be crossed by open bottom culverts that will promote fish passage.

### 5.2.1. Measures to Minimize Wildlife Impacts

During the initial planning stages of the project, Evergreen II evaluated specific potential project locations to minimize wetland and wildlife impacts. The alternatives analysis (Section 1A of this application) illustrates that this project results in the least impact possible, is proposed for the best possible location with regard to environmental impact, cost, geography, wind resource, and existing land use. Evergreen II will continue to work closely with USFWS during informal consultation to identify appropriate measures to minimize any impact to bald eagle, Canada lynx, and Atlantic salmon.

### 5.2.2. Post-Construction Avian and Bat Casualty Monitoring

In order to assess the bird and bat casualties from the Project, Evergreen II proposes a study protocol for post-construction monitoring during three of the first five years of operation (see Appendix 7-9). This protocol is based on the rapidly evolving methods associated with post construction assessment,

including the most recent efforts at Mars Hill, Stetson and Kibby, and will continue to evolve in consultation with MDIFW and USFWS.

## 6.0 CONCLUSION

The project area includes hills and ridges in the town of Oakfield and the unorganized territory T4R3, Aroostook County, Maine. This area has features typical of most areas in Northern Maine: sparsely populated with on-going agriculture and timber harvest activities. The development of the project will impact some wildlife habitat, but not at a level that would adversely affect their populations. Additionally, this project is not expected to diminish the natural communities present within the project area. This project has been designed to avoid wetland and other natural resource impacts to the greatest extent possible.

## 7.0 CITATIONS

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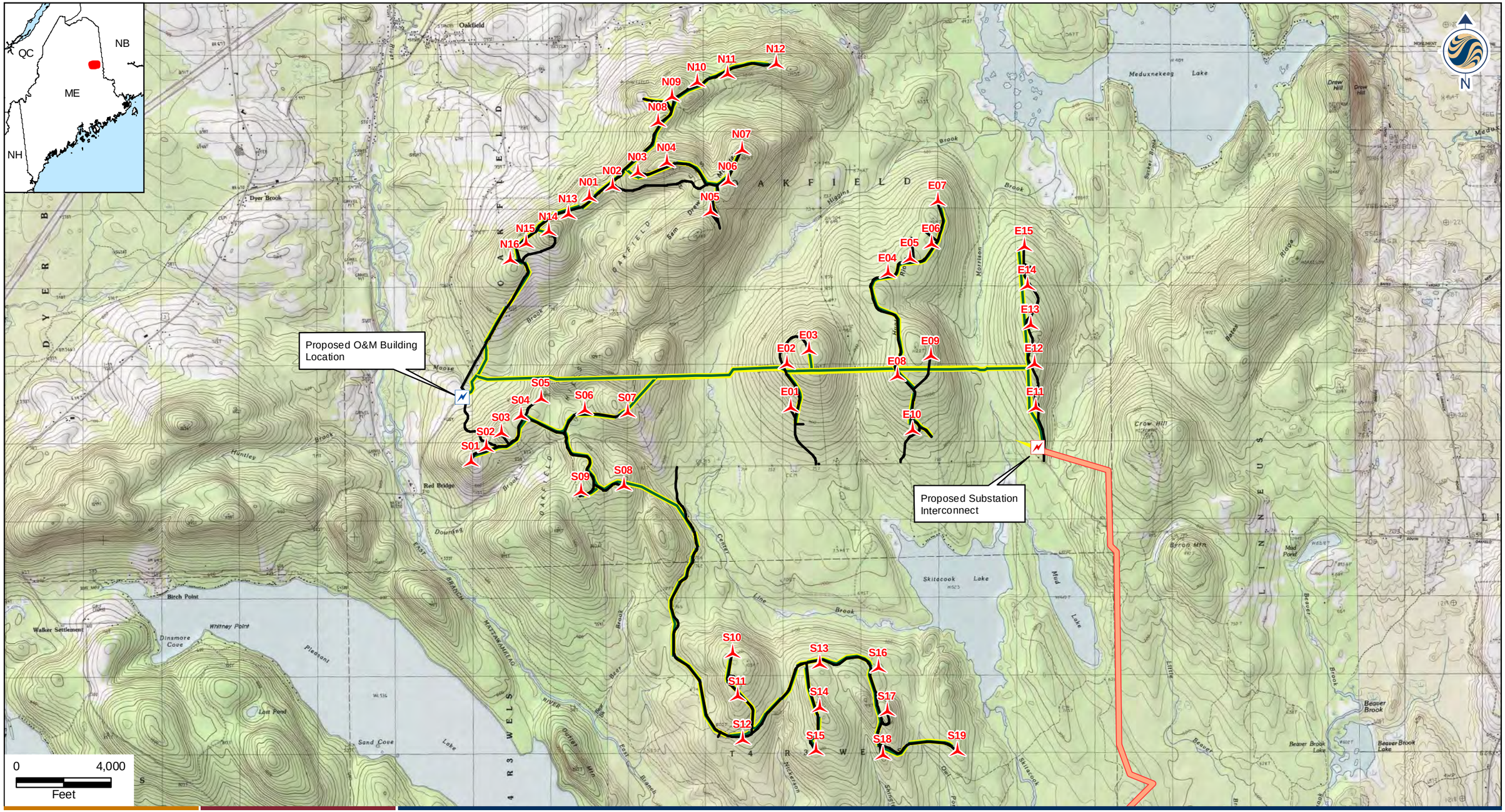
# Figure 1
# Project Location Map

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**Legend**

- Proposed Turbine (Vestas 50)
- Proposed 115kv Transmission Corridor
- Proposed Collector Corridor
- Proposed Access Roads

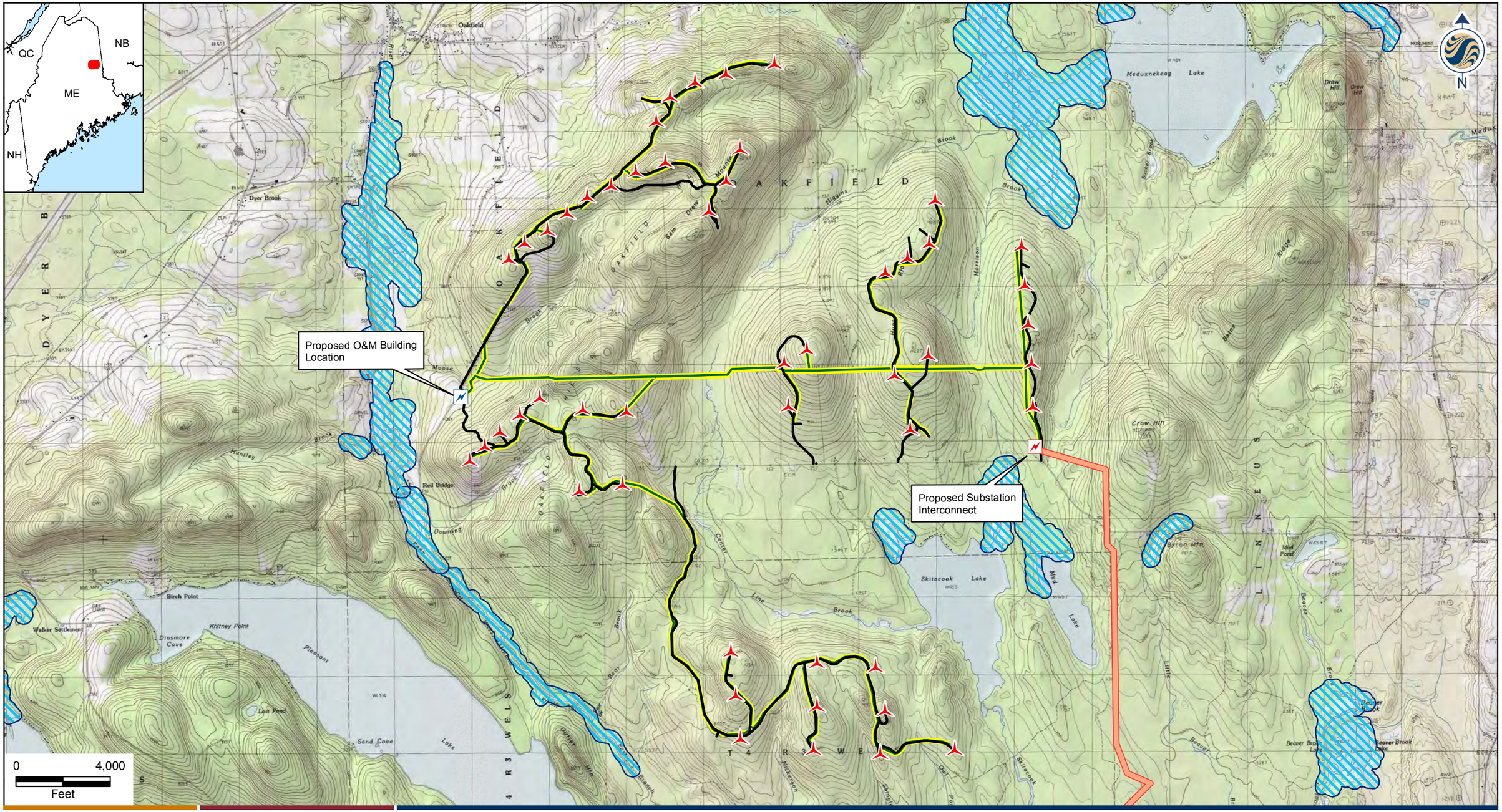
195600518

Client/Project
Evergreen Wind Power II, LLC
Oakfield Wind Project Amendment
Oakfield, Maine

Figure No.
1

Title
Summit Project Development Area
May 2011

# Figure 2
# Locations of Inland Wading Bird and Waterfowl Habitat





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**Legend**

- Proposed Turbine (Vestas 50)
- Proposed 115kv Transmission Corridor
- Proposed Collector Corridor
- Proposed Access Roads
- Inland Waterfowl and Wading Bird Habitat

195600518

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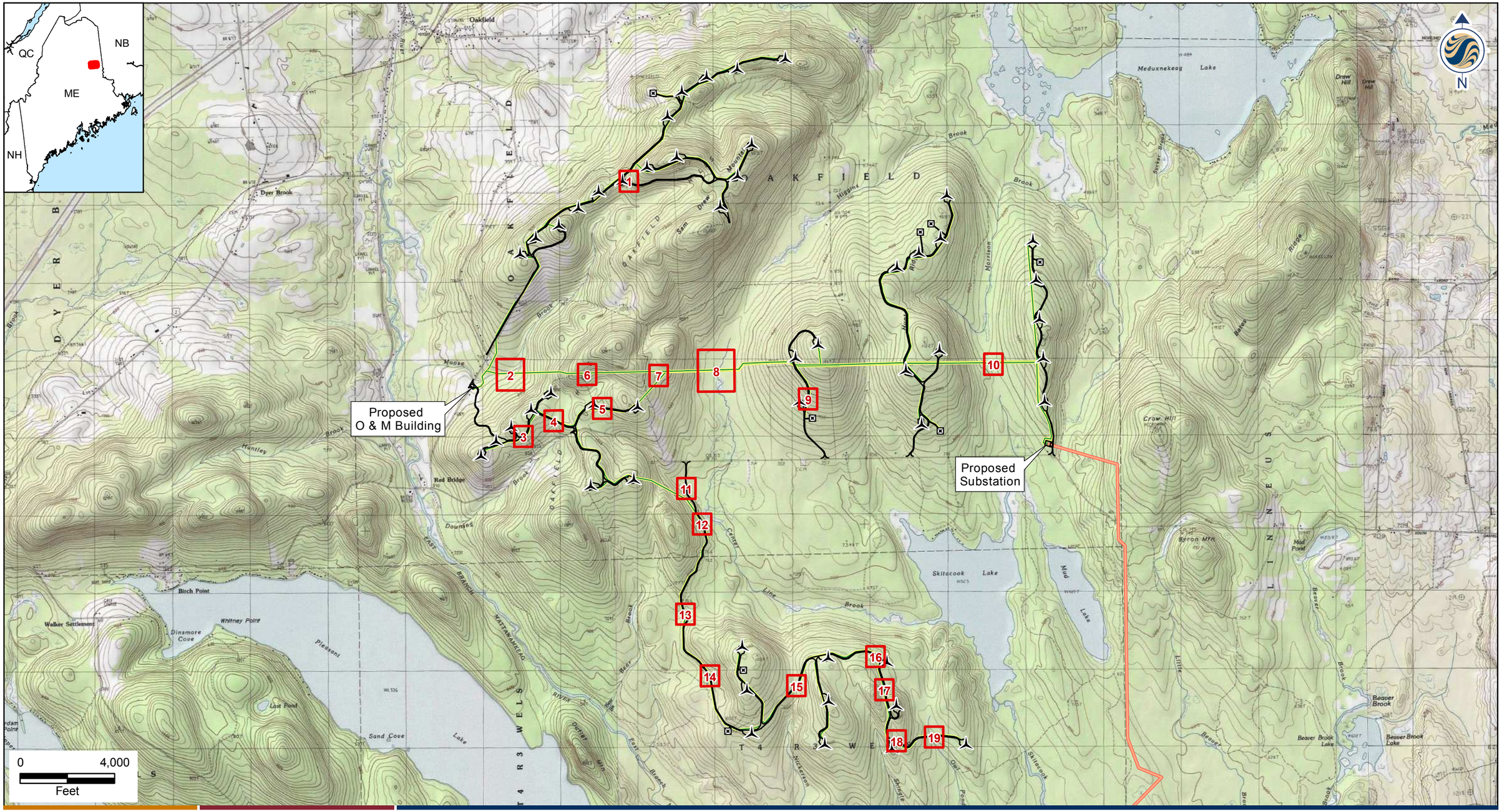
**Evergreen Wind Power II, LLC**
**Oakfield Wind Project Amendment**
**Oakfield, Maine**

Figure No.
**2**

Title
**Summit Project Development Area**
**May 2011**

# Appendix 7-1
# Wetland and Waterbody Resource Delineation and Vernal Pool Survey Report
# Oakfield Wind Project Amendment, July 2010

# Appendix 7-2
# Resource Impacts

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**Legend**

- Proposed Turbine
- Proposed MET Tower
- Proposed Road
- Collector Corridor
- 115kV Transmission Corridor
- Resource Impact Map

195600518

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**Oakfield, Maine**

Figure No.
**Key**

Title
**Summit Resource Impact Map**

May 2011

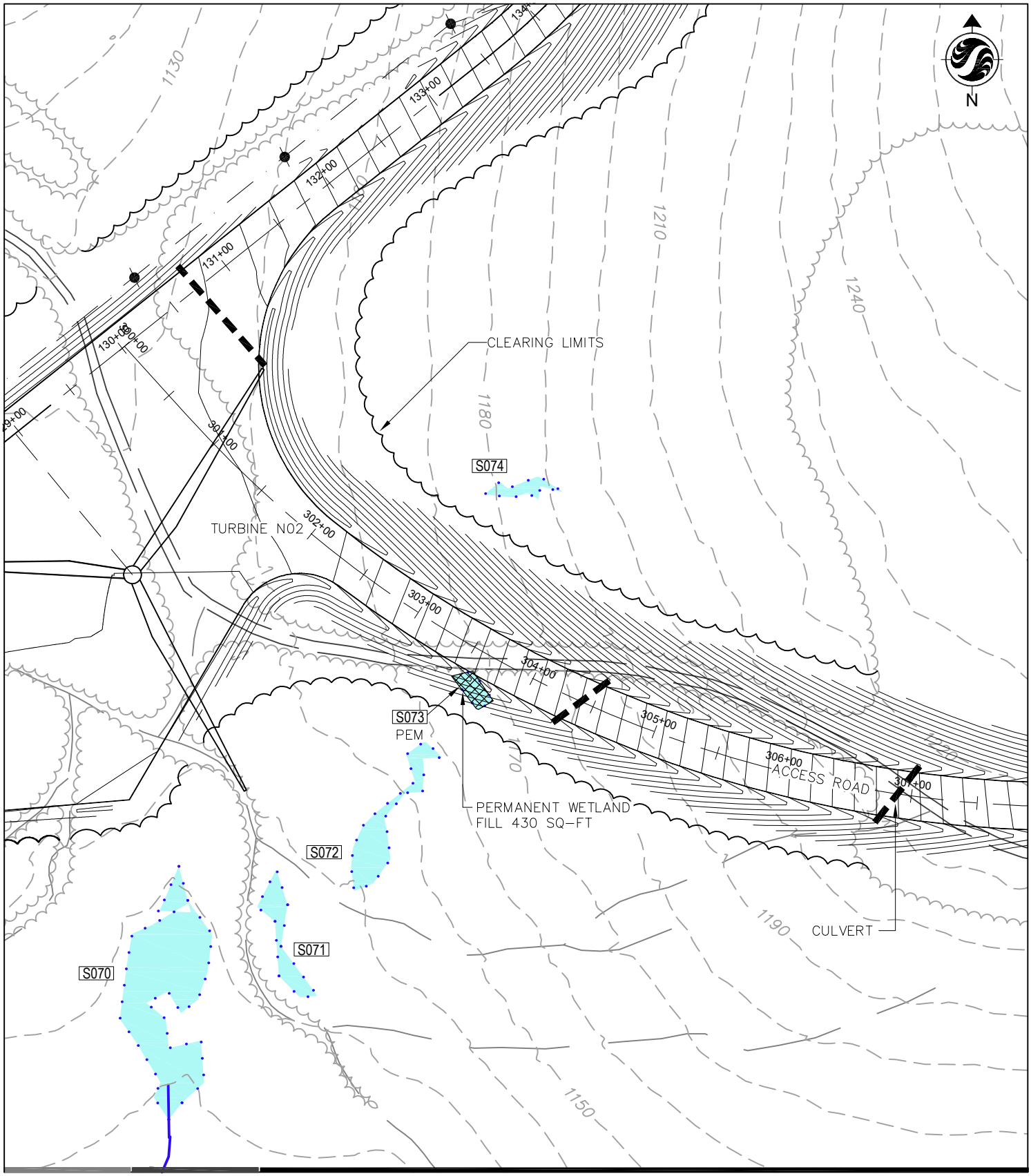



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Figure No.
1

Title
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May 2011

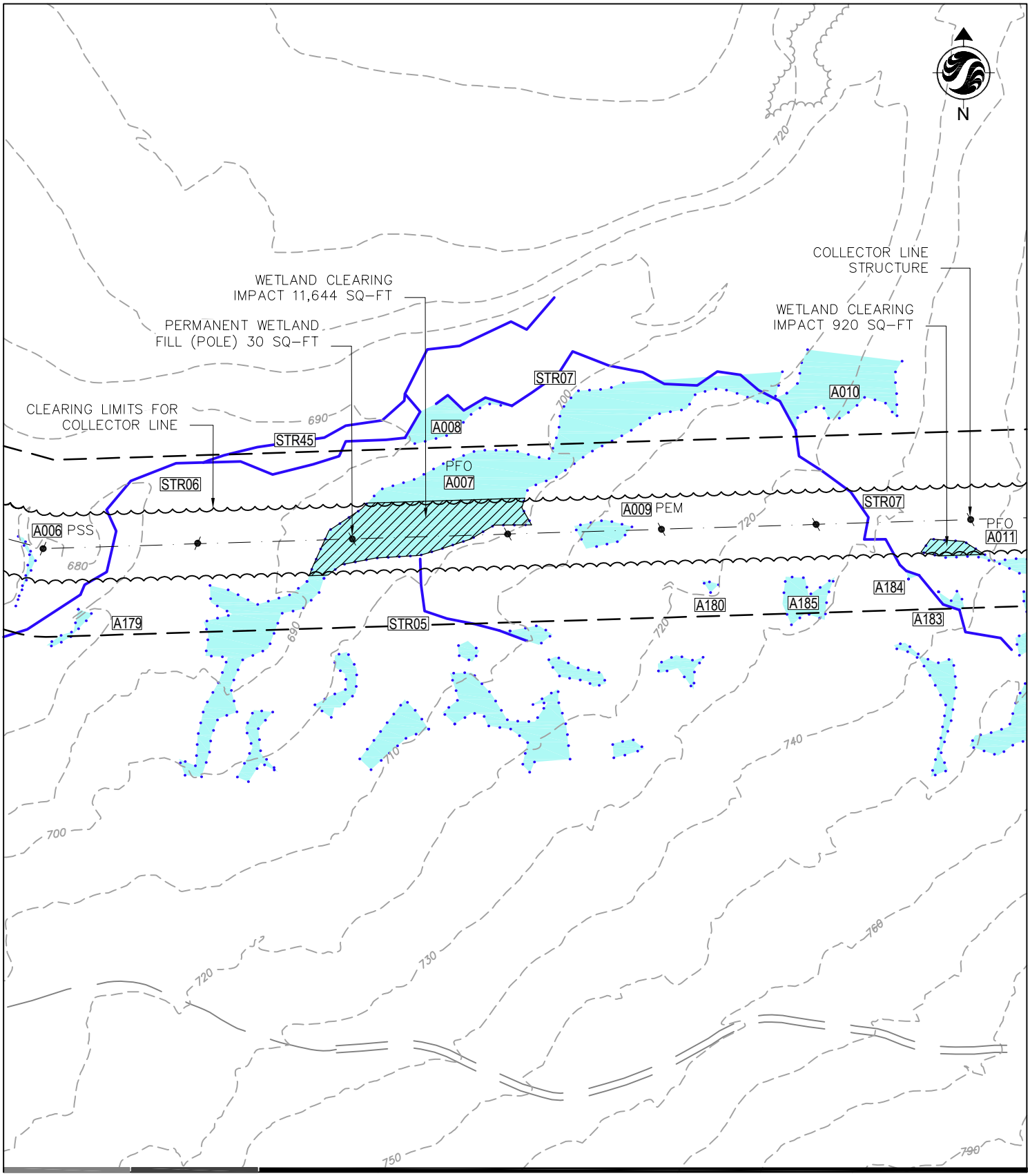



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Figure No.
**2**

Title
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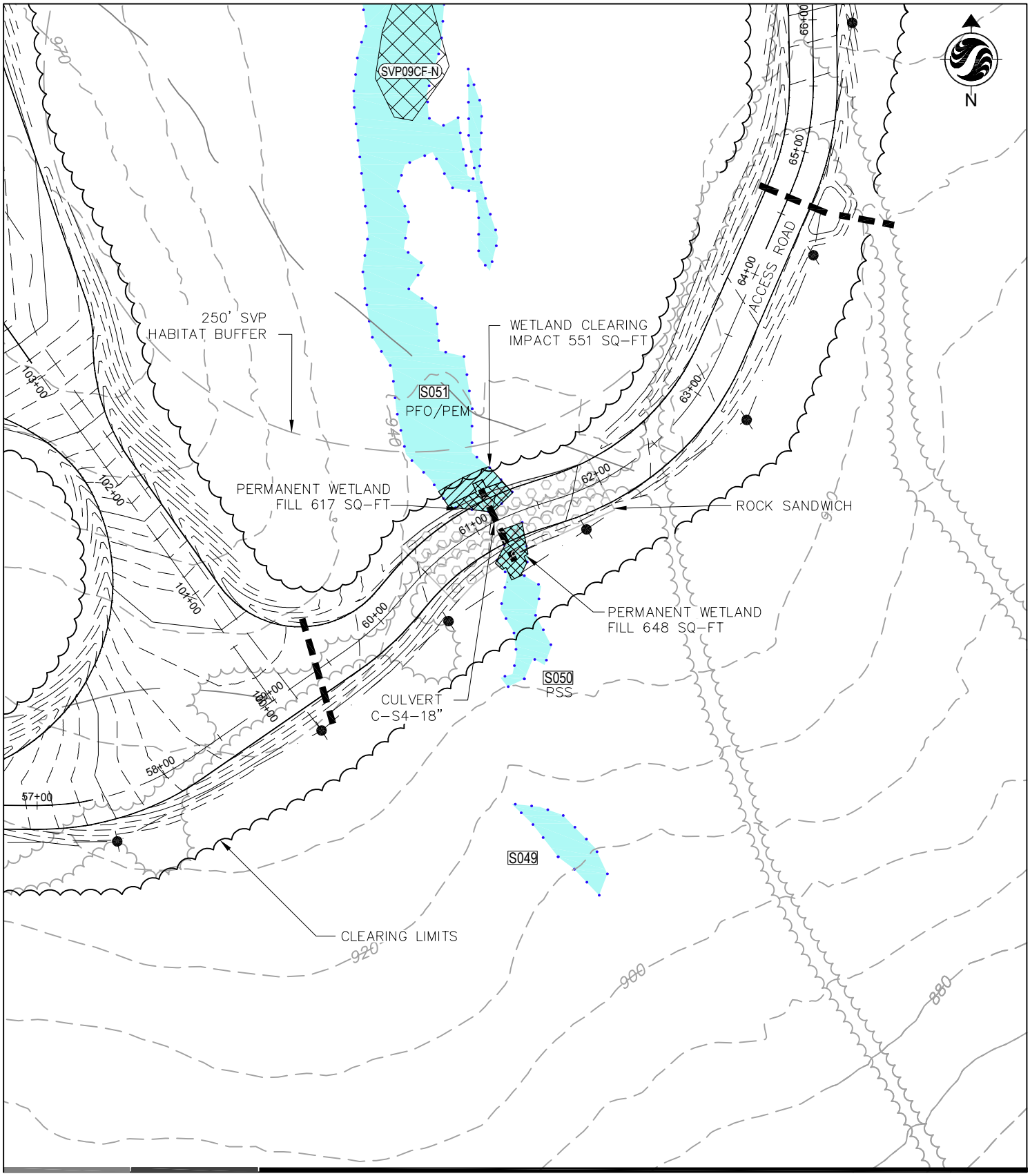



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Figure No.
**3**

Title
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May 2011

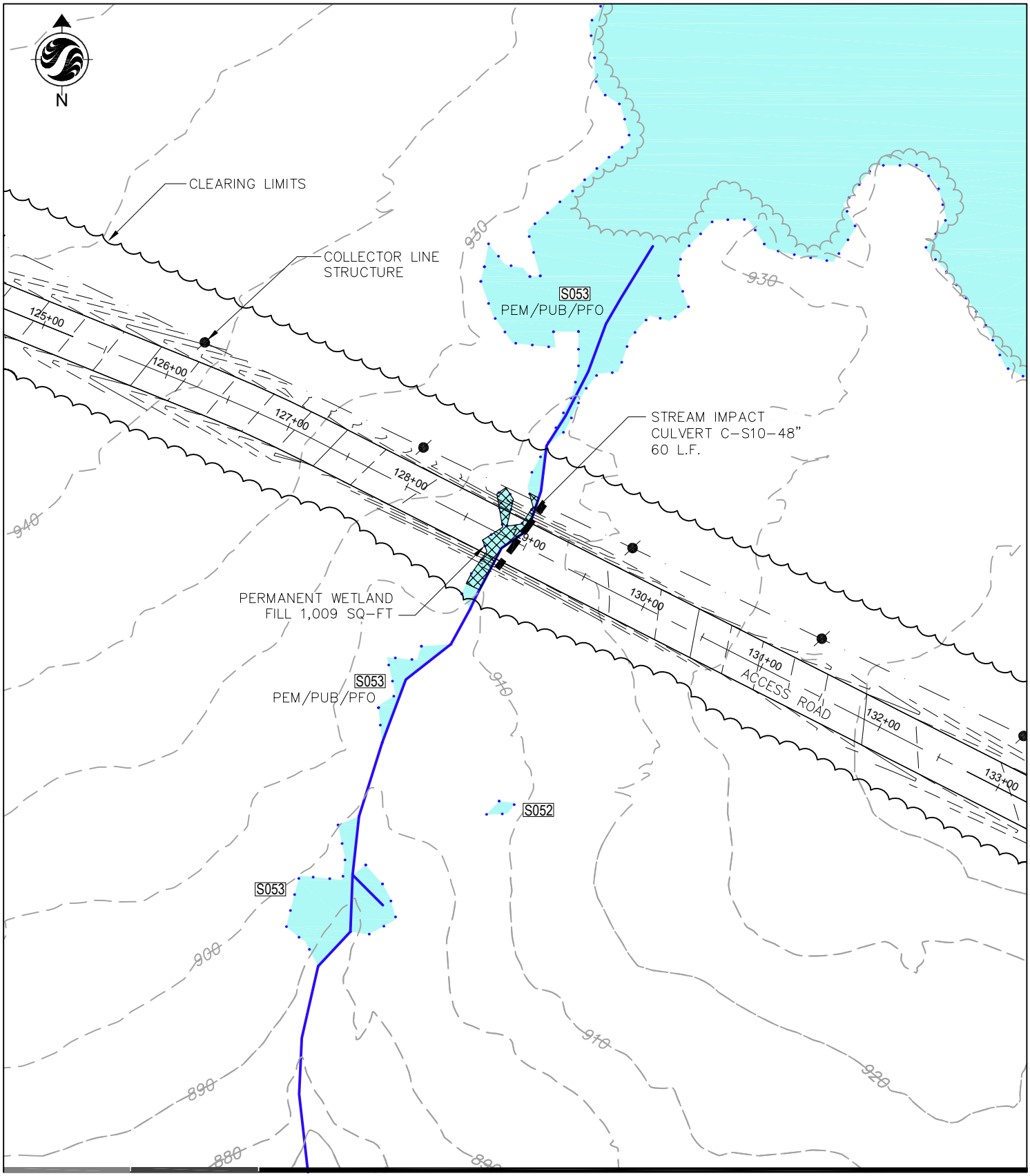



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Figure No.
**4**

Title
**Summit Wetland Impact**

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May 2011

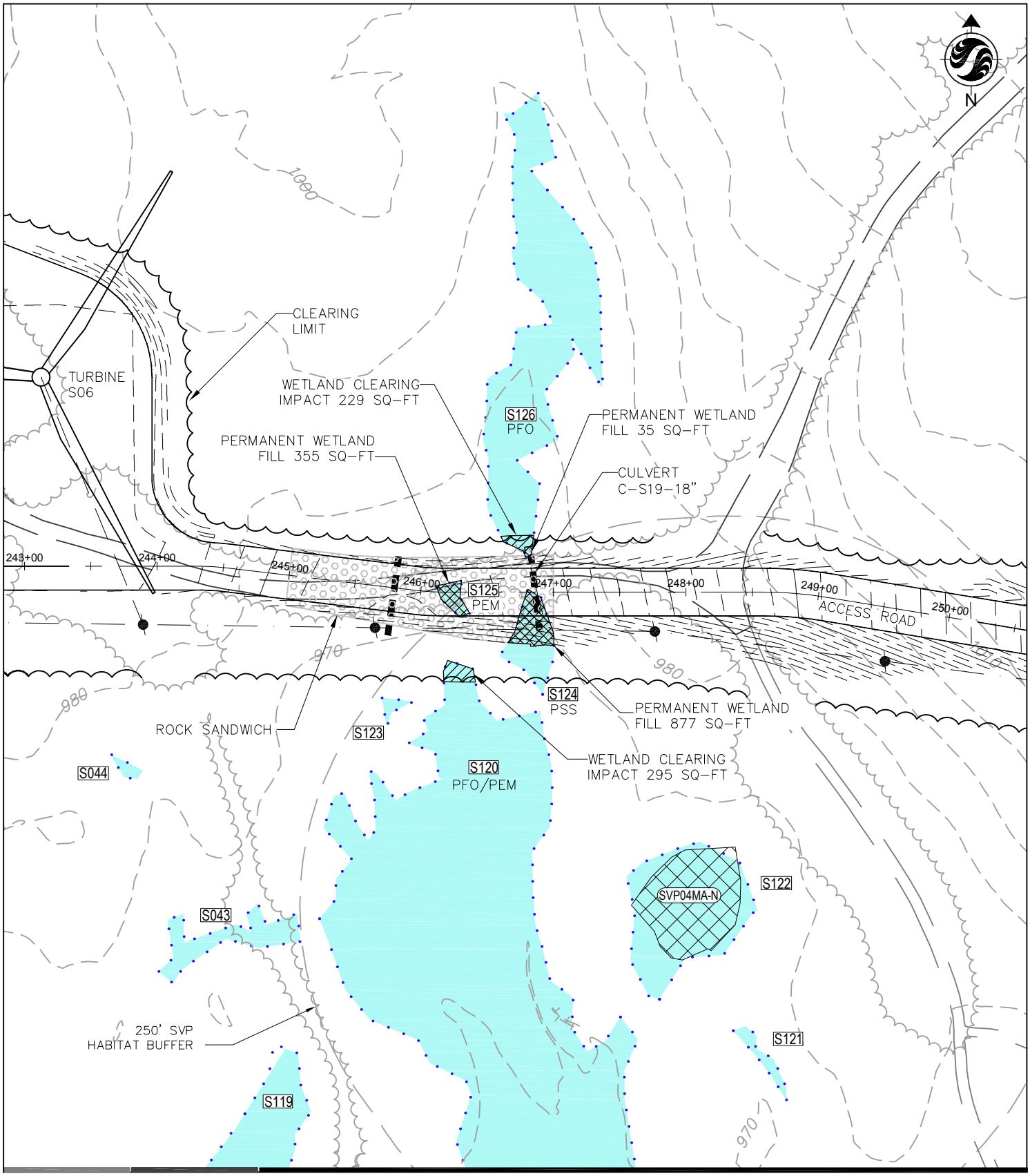



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Figure No.
**5**

Title
**Summit Wetland Impact**

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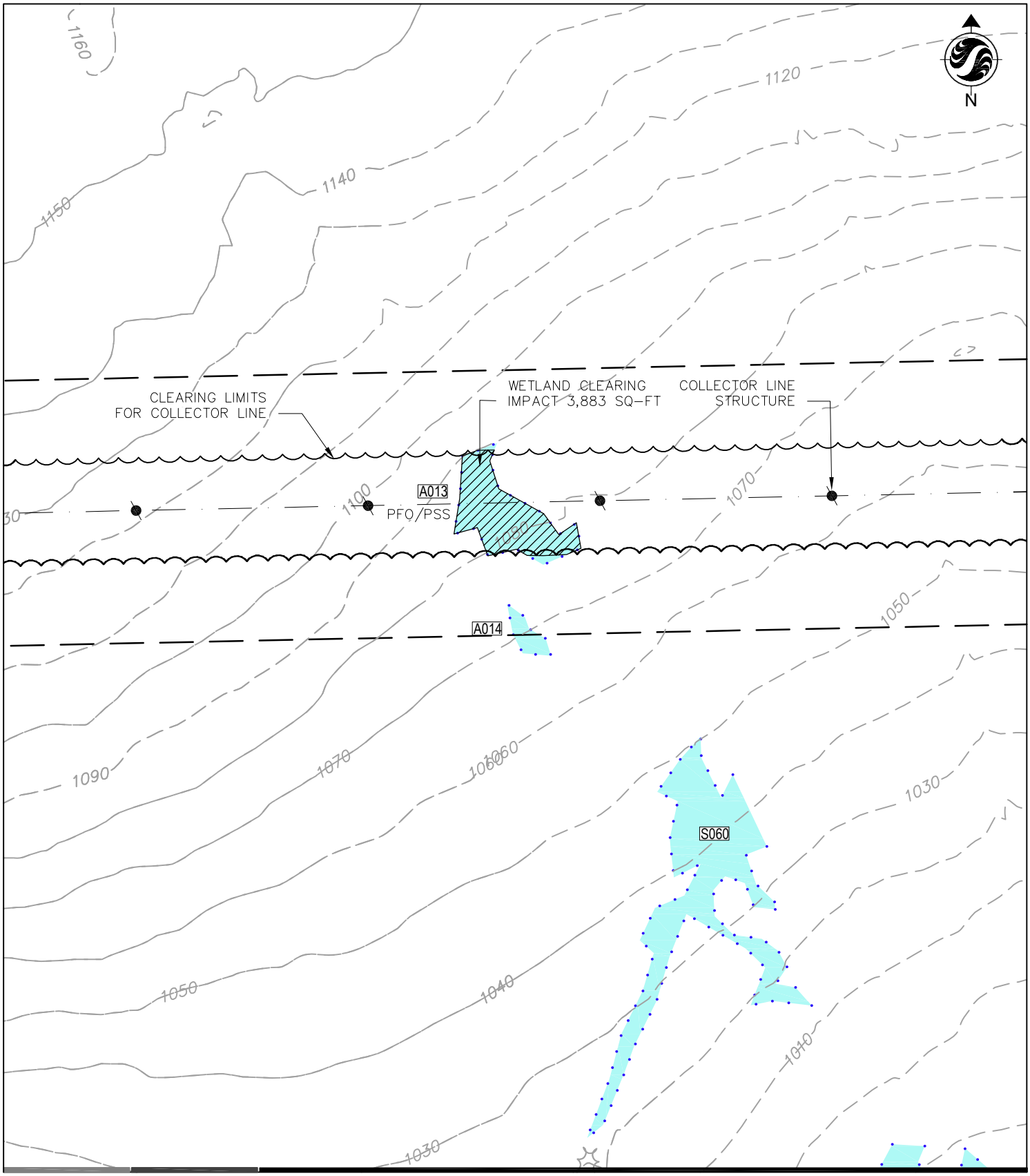



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Oakfield, Maine

Figure No.
**6**

Title
**Summit Wetland Impact**

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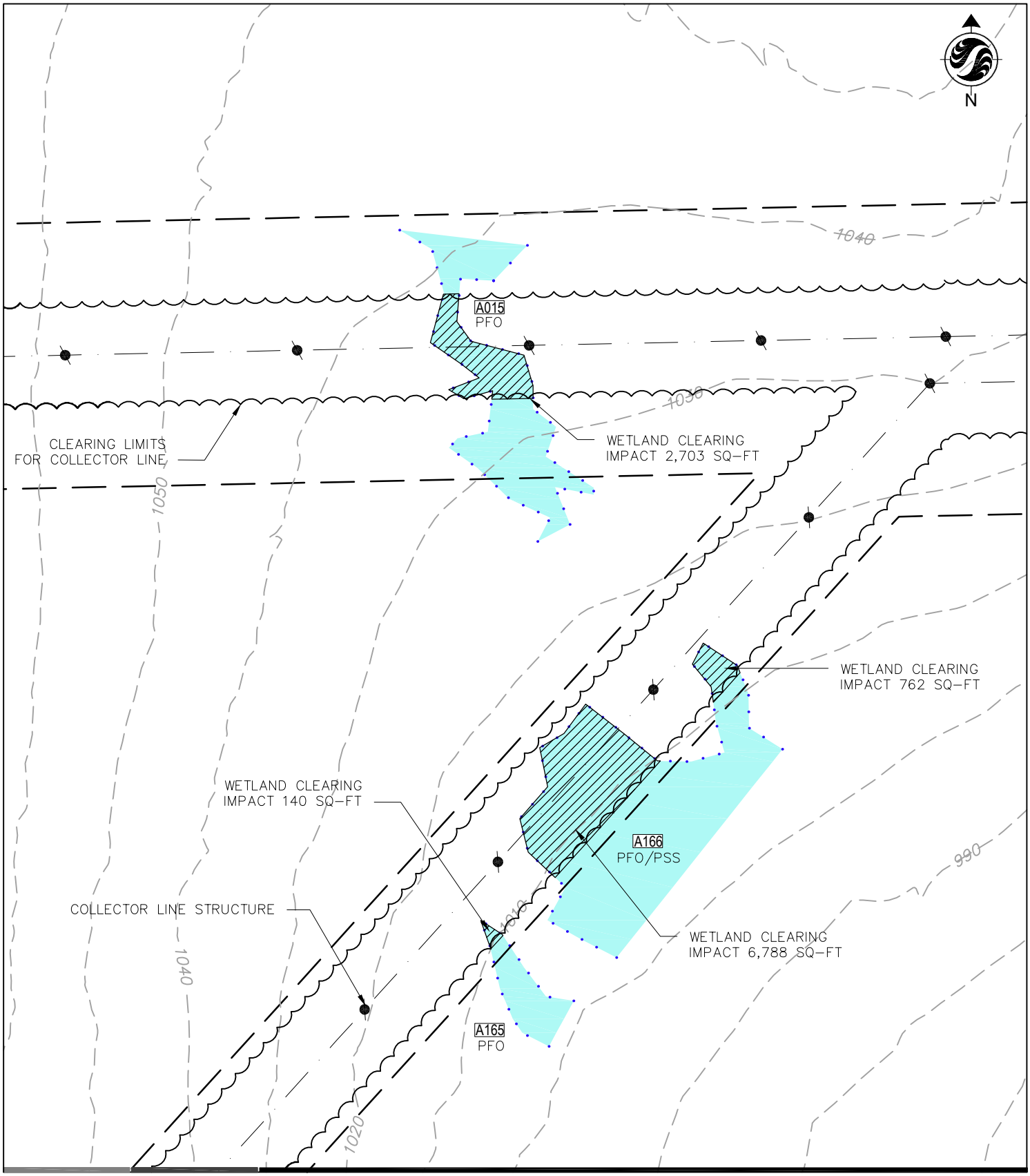


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Figure No.
**7**

Title
**Summit Wetland Impact**

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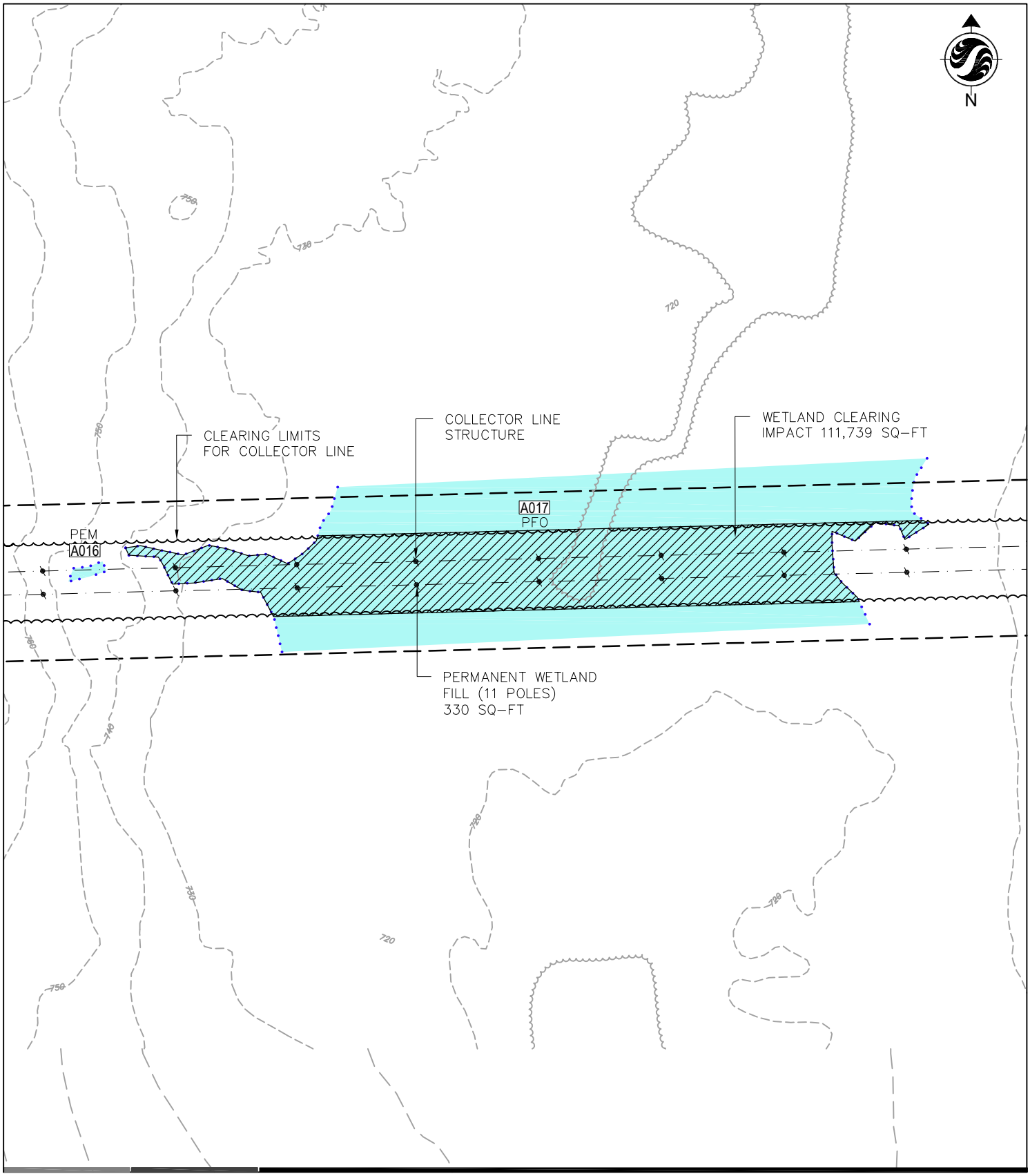
May 2011

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Oakfield, Maine

Figure No.
**8**

Title
**Summit Wetland Impact**

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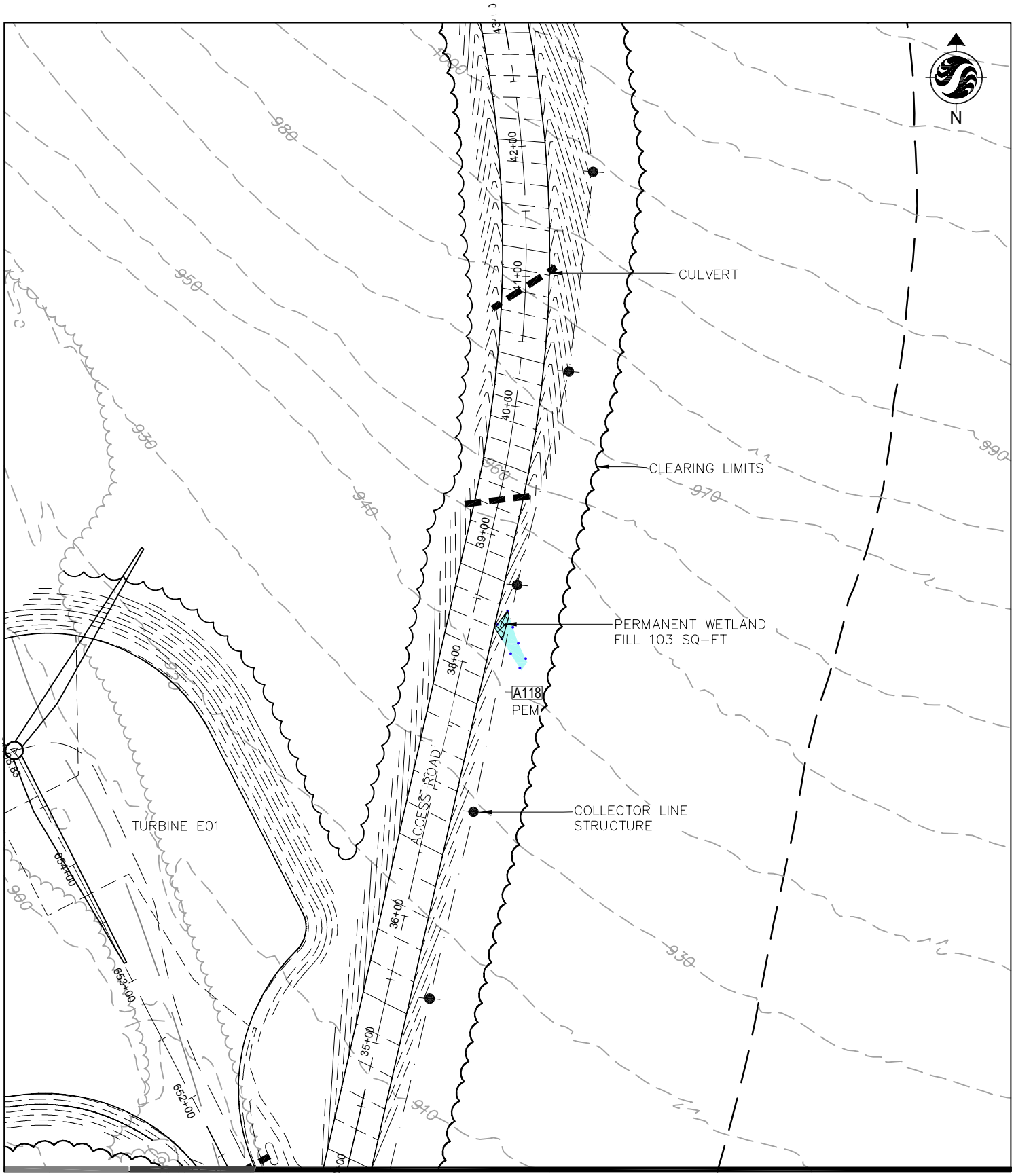



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Figure No.
**9**

Title
**Summit Wetland Impact**

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May 2011

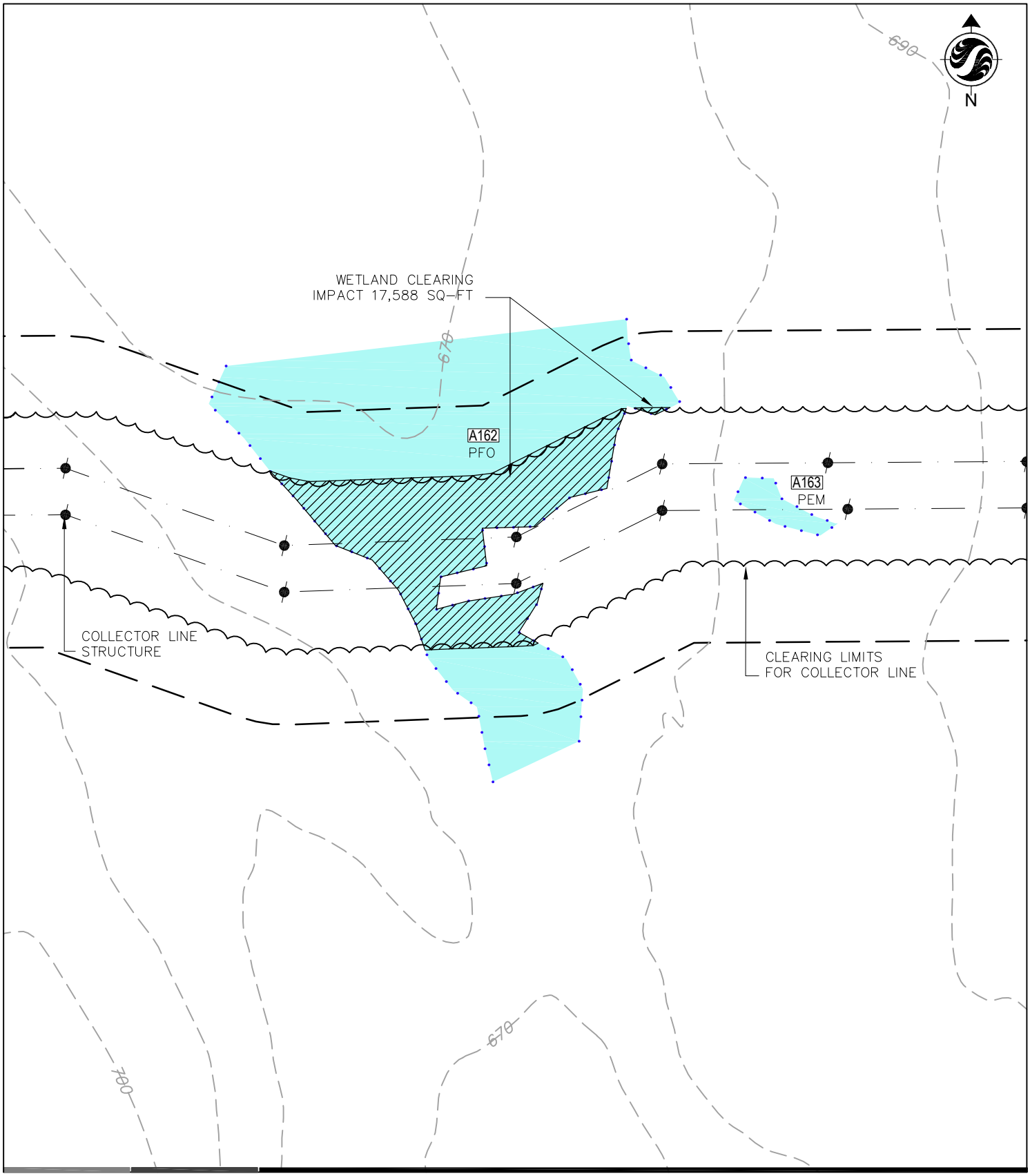


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Figure No.
**10**

Title
**Summit Wetland Impact**

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May 2011

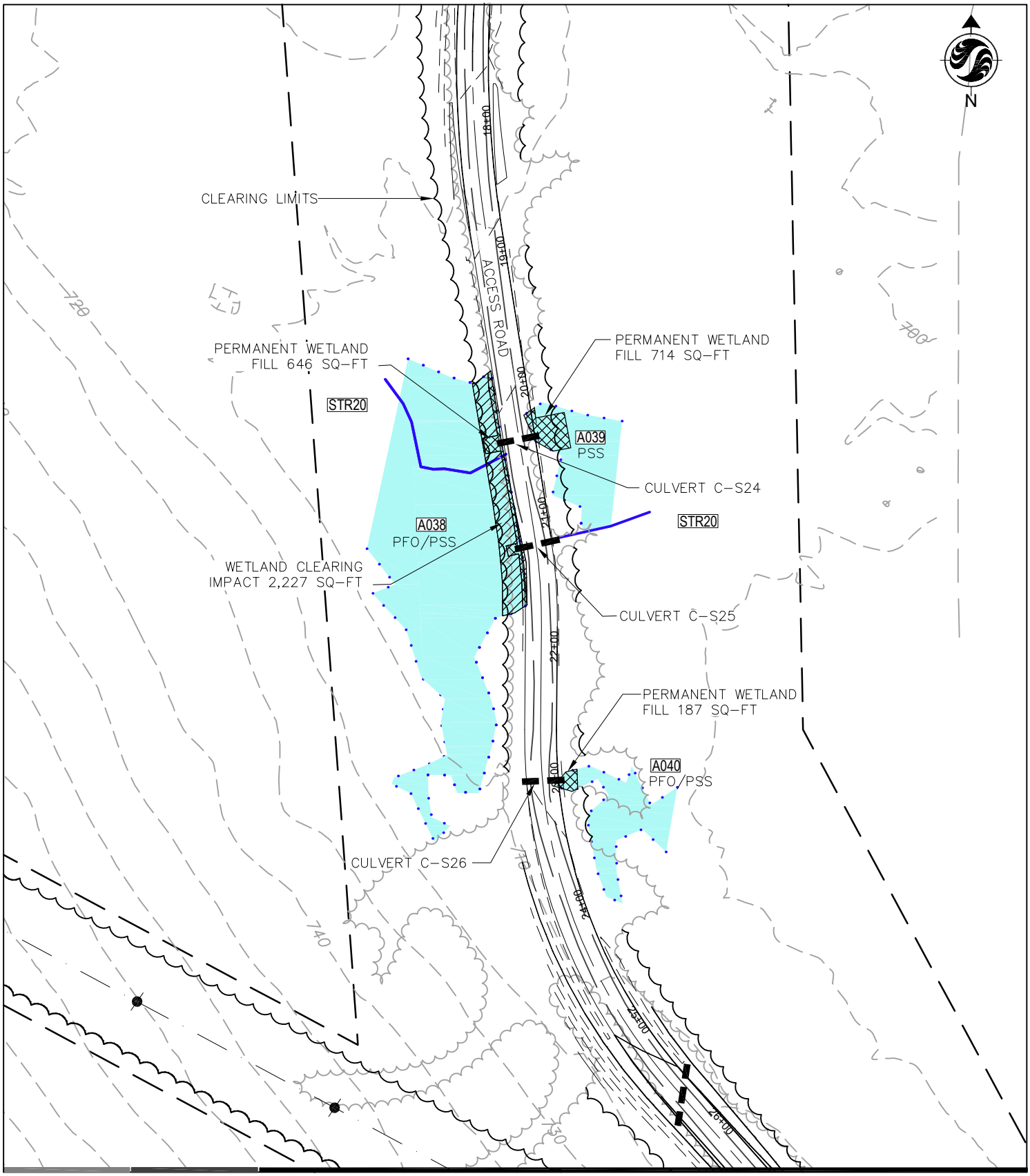



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Figure No.
**11**

Title
**Summit Wetland Impact**

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May 2011

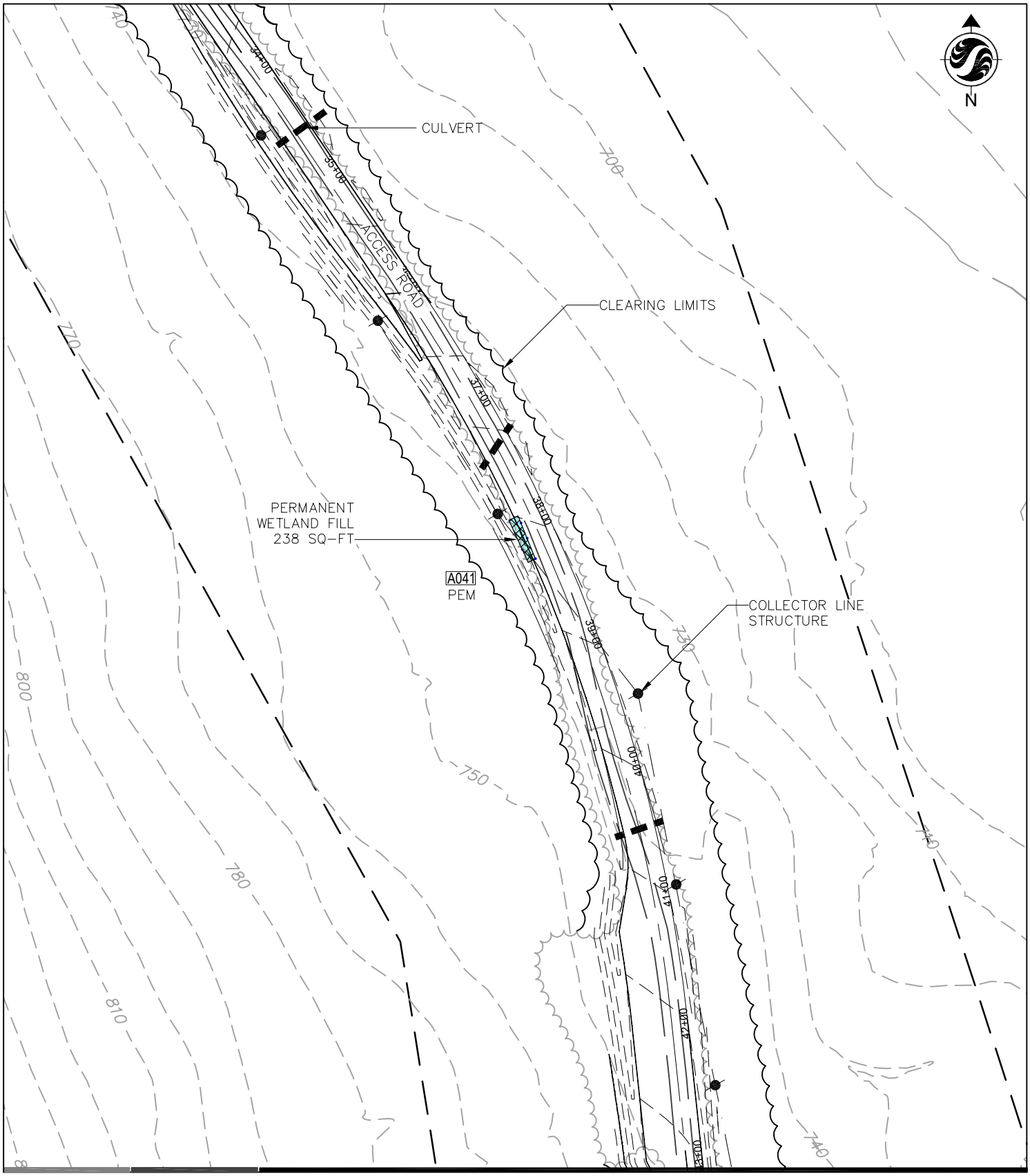



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Figure No.
**12**

Title
**Summit Wetland Impact**

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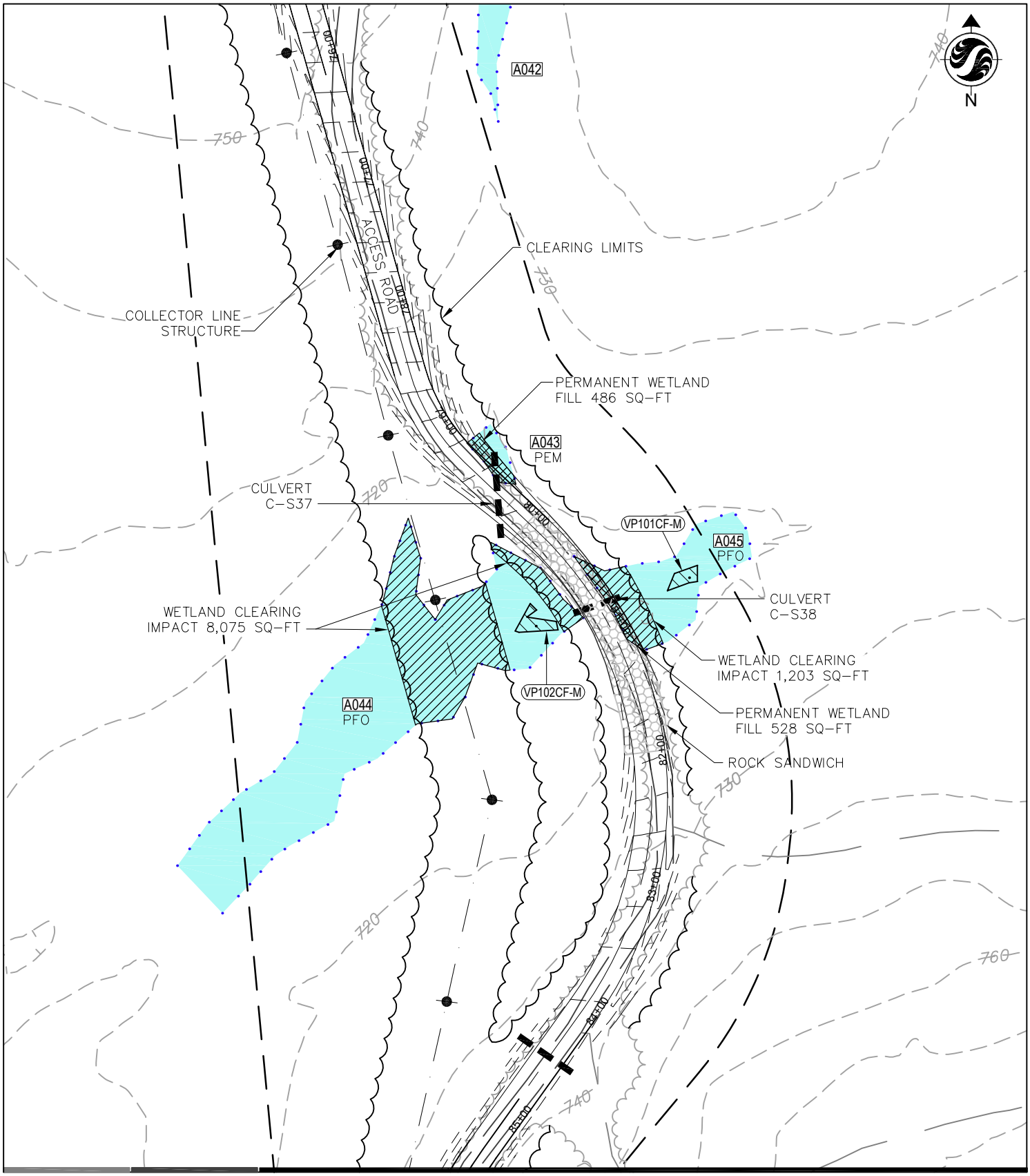



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Figure No.
**13**

Title
**Summit Wetland Impact**

00518-00-ImpactMaps-Summit.dwg

May 2011

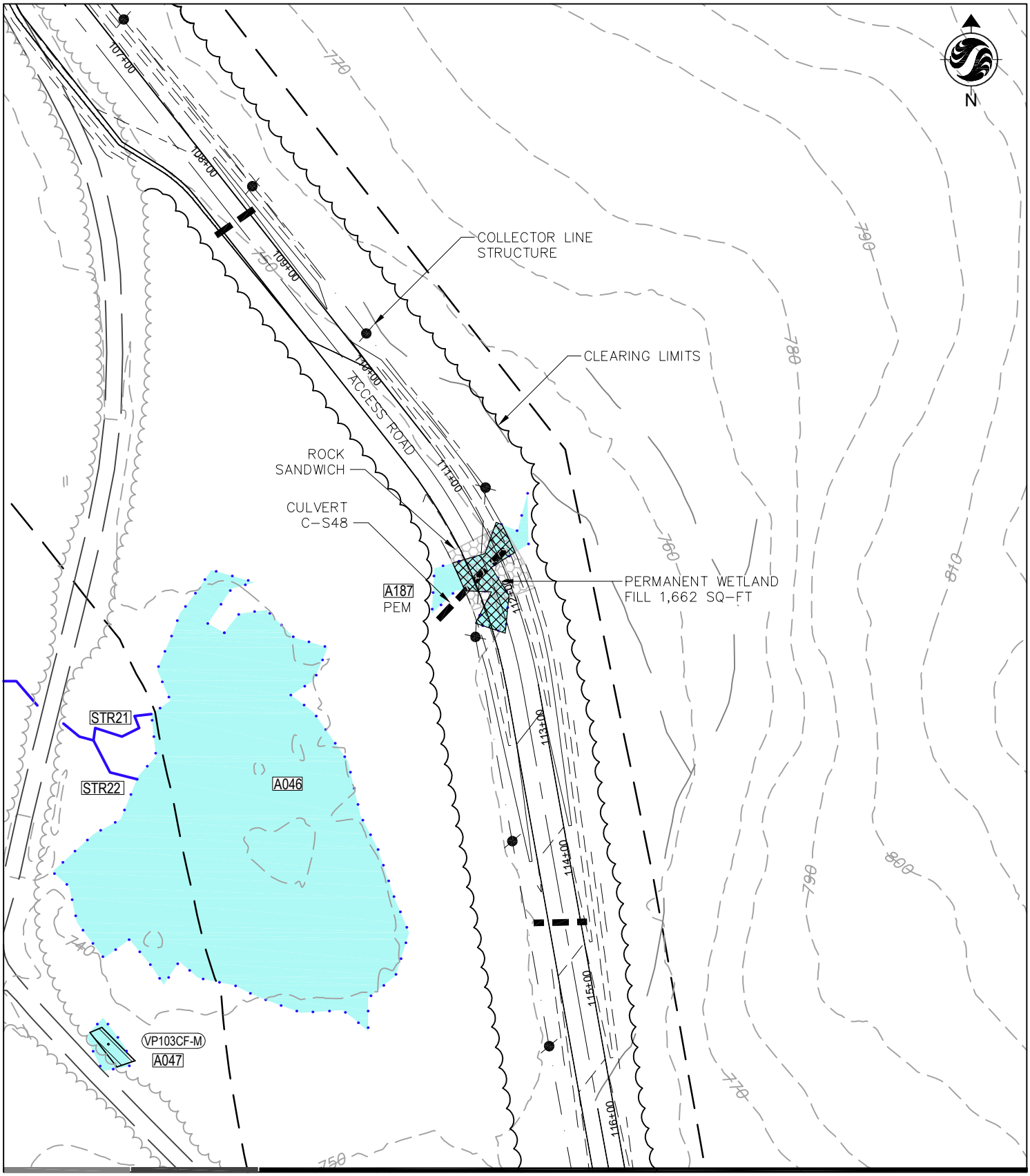



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Figure No.
**14**

Title
**Summit Wetland Impact**

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May 2011

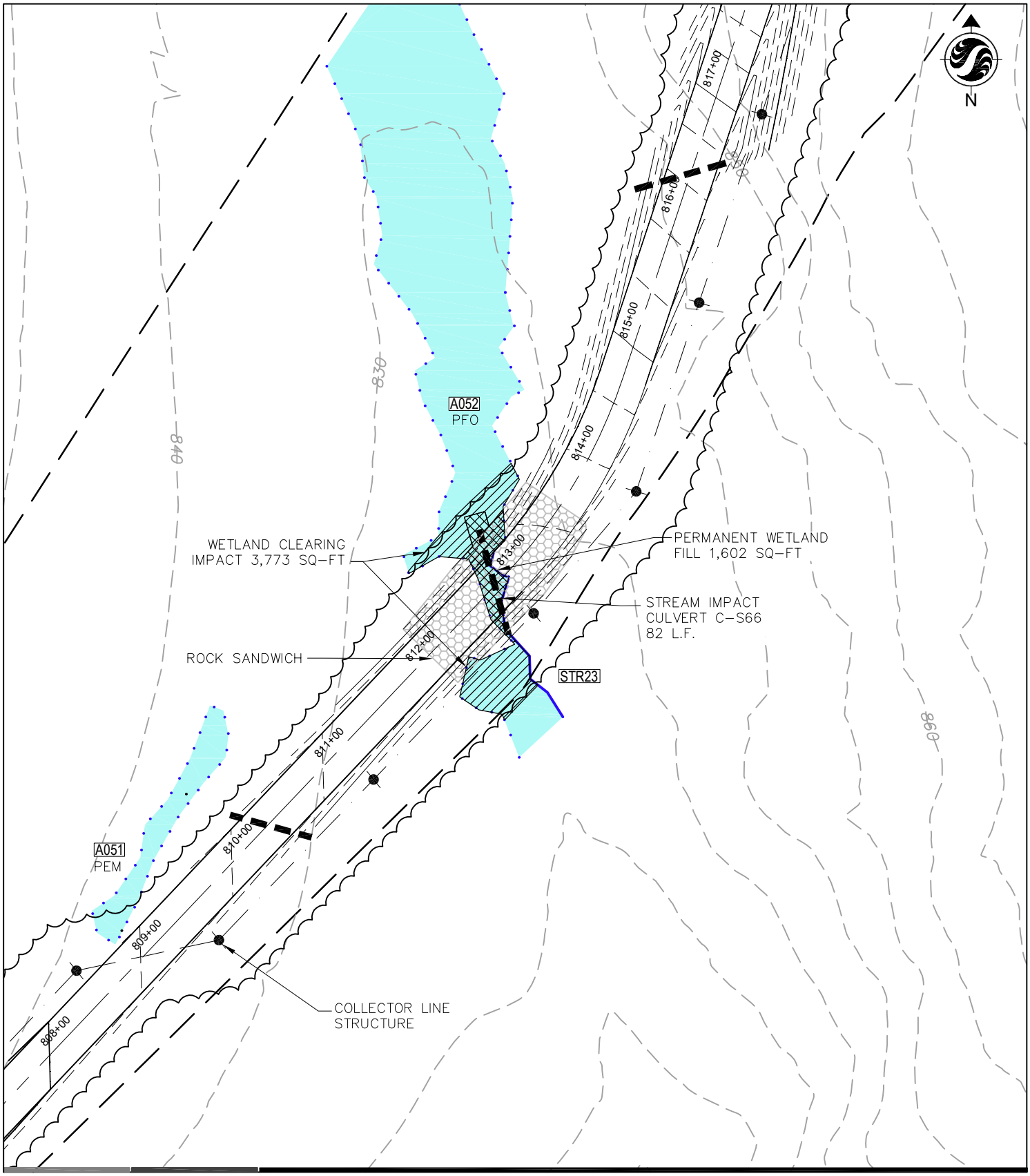



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Figure No.
**15**

Title
**Summit Wetland Impact**

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May 2011

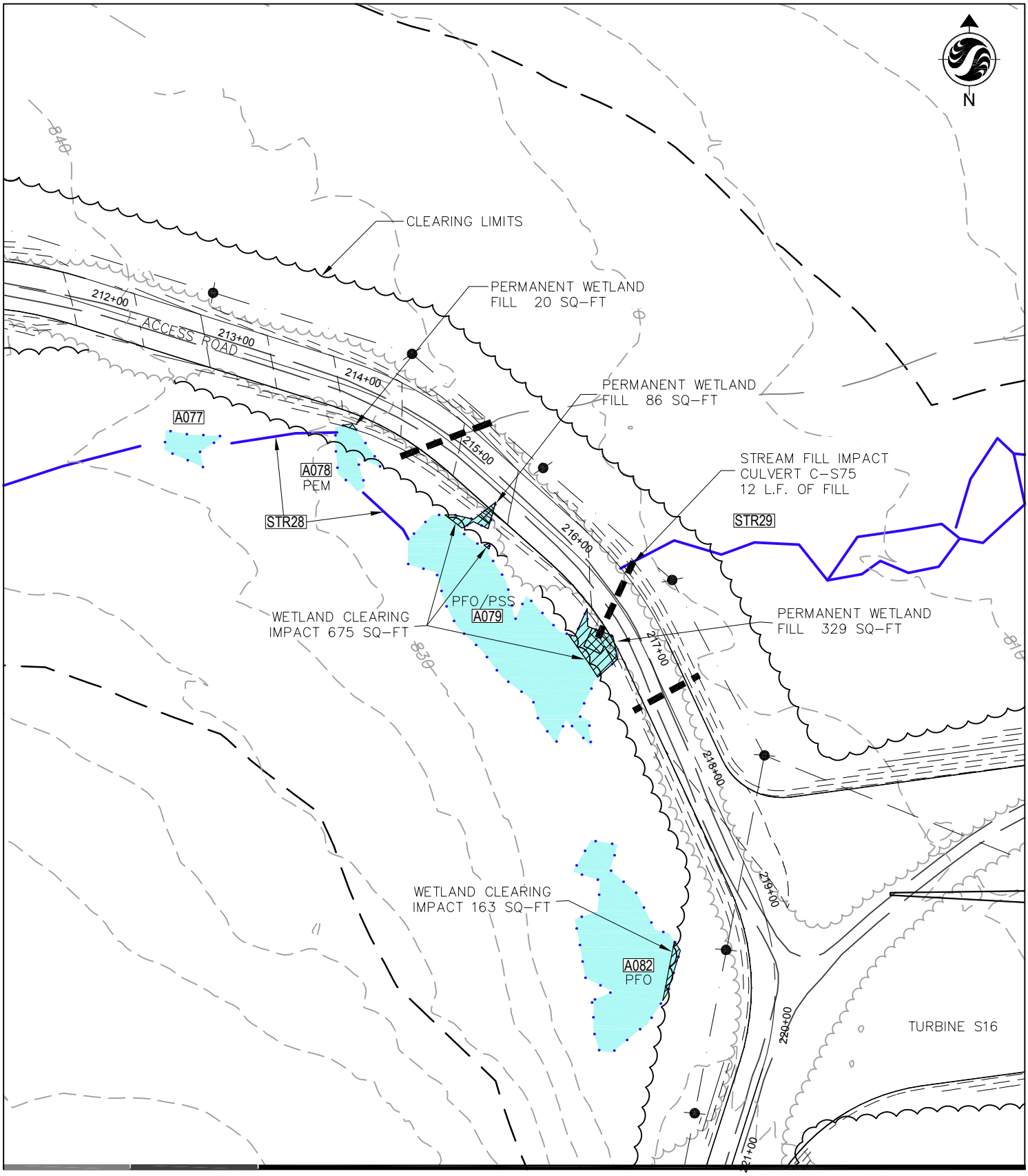



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Figure No.
**16**

Title
**Summit Wetland Impact**

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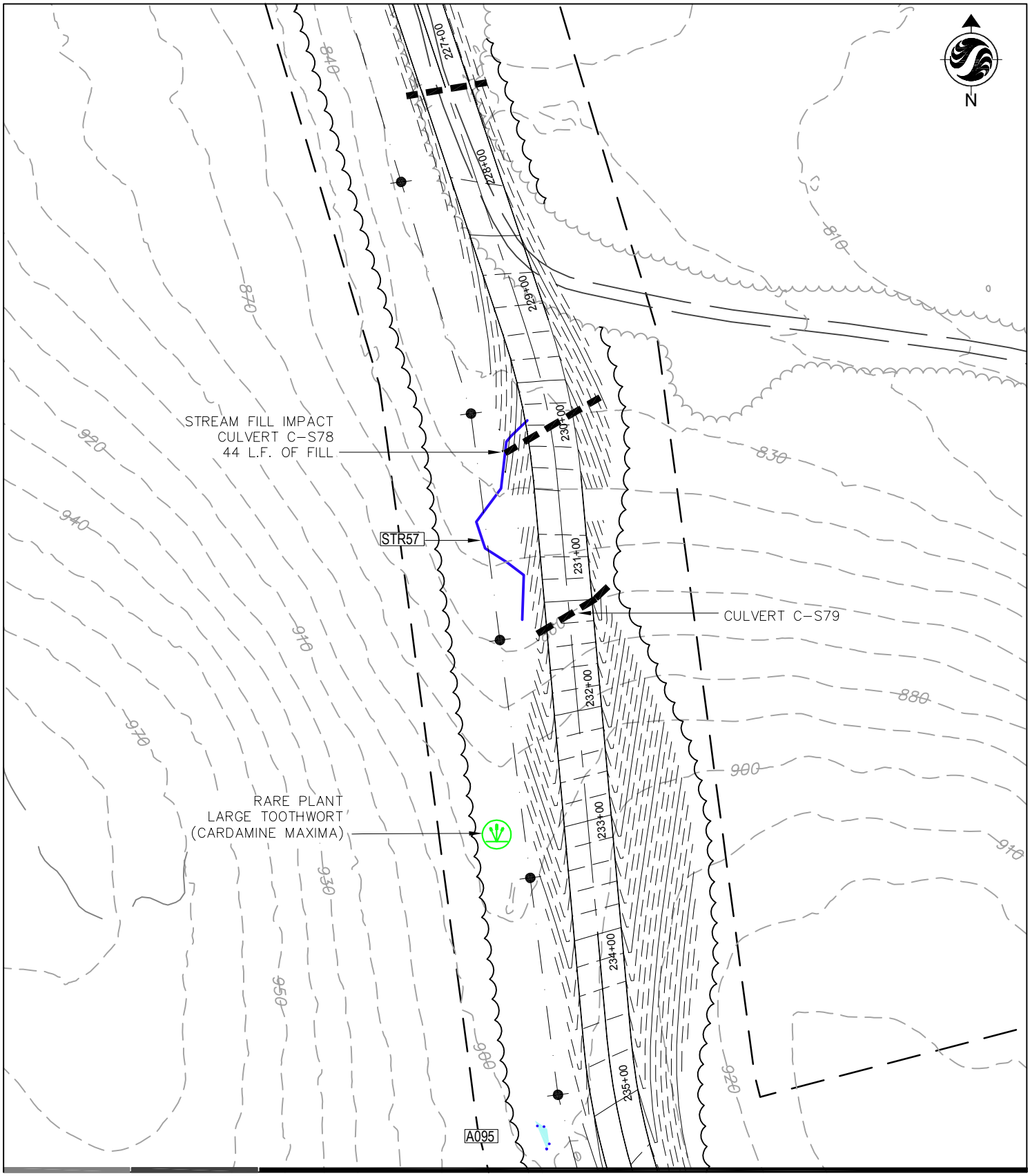



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Figure No.
**17**

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**Summit Wetland Impact**

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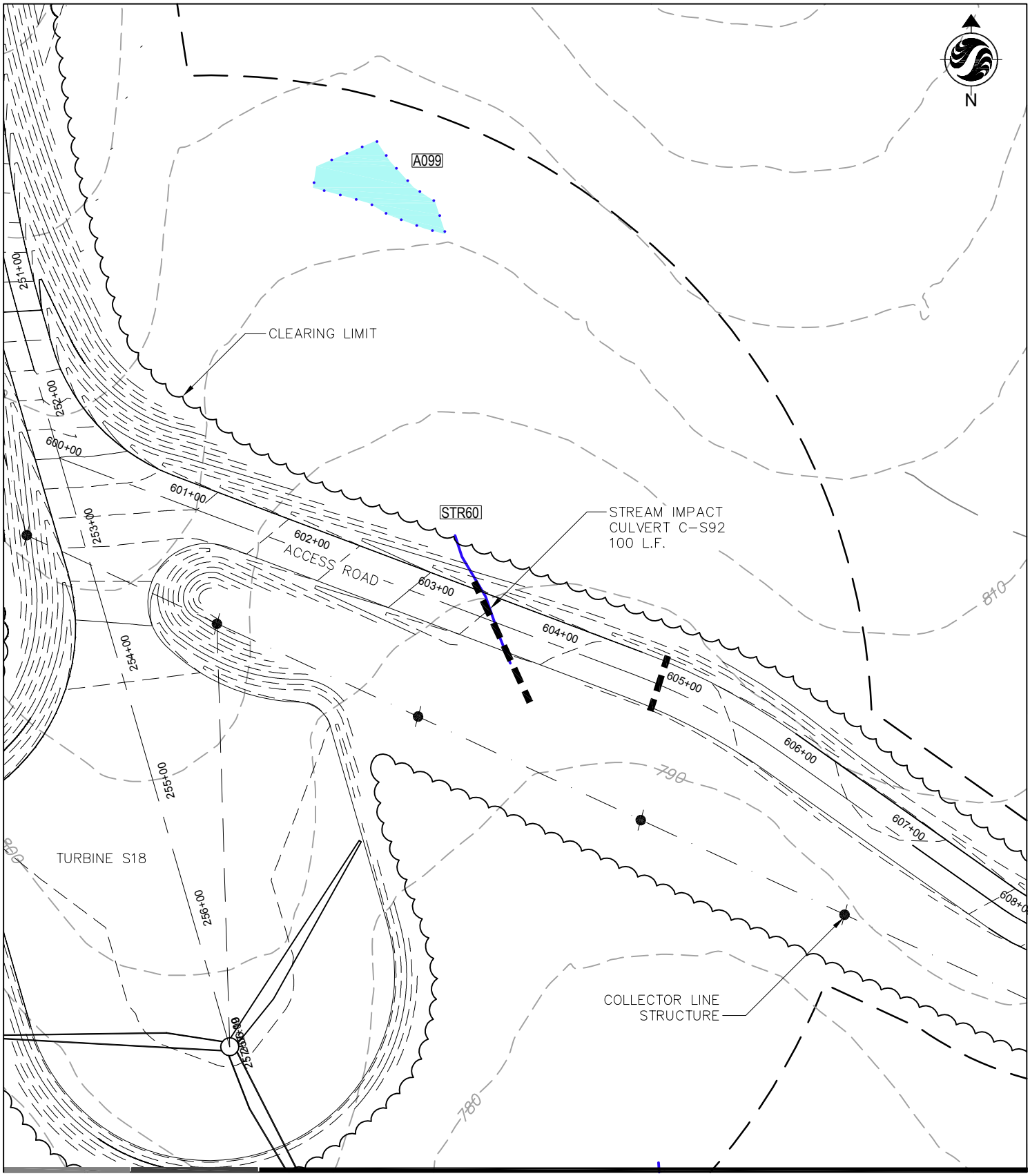



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Oakfield, Maine

Figure No.
**18**

Title
**Summit Wetland Impact**

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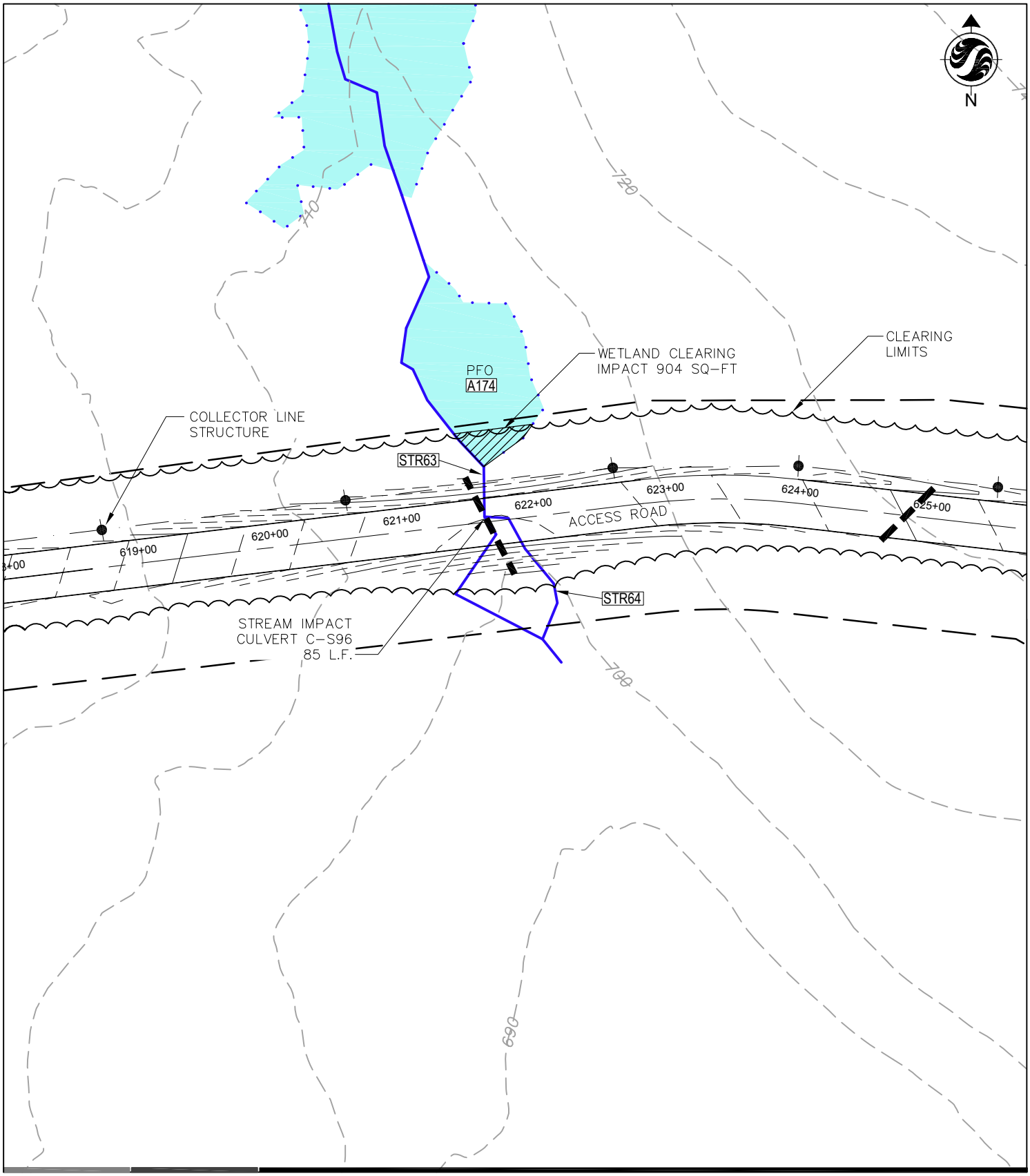
May 2011





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Oakfield, Maine

Figure No.
**19**

Title
**Summit Wetland Impact**

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May 2011

# Appendix 7-3
# List of Wildlife Species Observed within the Project Area

| Common Name | Scientific Name |
|---|---|
| **Mammal** | |
| moose | *Alces alces* |
| white-tailed deer | *Odocoileus virginianus* |
| black bear | *Ursus americanus* |
| snowshoe hare | *Lepus americanus* |
| meadow vole | *Microtus pennsylcanicus* |
| coyote (scat, tracks) | *Canis latrans* |
| red squirrel | *Tamiasciurus hudsonicus* |
| gray squirrel | *Sciurus carolinensis* |
| **Amphibian and Reptile** | |
| wood frog | *Lithobates sylvatica* |
| spotted salamander | *Ambystoma maculatum* |
| green frog | *Lithobates clamitans* |
| maritime garter snake | *Thamnophis sirtalis pallidula* |
| blue-spotted salamander | *Ambystoma laterale* |
| American toad | *Bufo americanus* |
| **Bird** | |
| ruffed grouse | *Bonasa umbellus* |
| American robin | *Turdus migratorius* |
| white-throated sparrow (heard) | *Zonotrichia albicollis* |
| white-eyed vireo (heard) | *Vireo griseus* |
| hairy wood-pecker | *Picoides villosus* |
| American woodcock | *Scolopax minor* |
| black-capped chickadee | *Poecile atricapillus* |
| blue jay | *Cyanicitta cristata* |
| red-tailed hawk | *Buteo jamaicensis* |
| sharp-shinned hawk | *Accipiter striatus* |
| turkey vulture | *Cathartes aura* |
| merlin | *Falco columbarius* |
| American kestrel | *Falco sparverius* |
| northern goshawk | *Accipiter gentilis* |
| rose-breasted grosbeak | *Pheucticus ludovicianus* |
| American goldfinch | *Carduelis tristis* |
| black-and-white warbler | *Mniotilta varia* |
| dark-eyed junco | *Junco hyemalis* |
| red-eyed vireo | *Vireo olivaceus* |
| American crow | *Corvus brachyrhynchos* |
| northern flicker | *Colaptes auratus* |
| common yellowthroat | *Geothlypis trichas* |
| golden-crowned kinglet | *Regulus satrapa* |
| magnolia warbler | *Dendroica magnolia* |
| northern parula | *Parula americana* |
| yellow warbler | *Dendroica petechia* |
| ruby-throated hummingbird | *Archilochus colubris* |
| yellow-bellied sapsucker | *Sphyrapicus varius* |
| alder flycatcher | *Empidonax alnorum* |
| yellow-rumped warbler | *Dendroica coronata* |
| chipping sparrow | *Spizella passerina* |

| Common Name | Scientific Name |
|---|---|
| black-throated green warbler | *Dendroica virens* |
| ruby-crowned kinglet | *Regulus calendula* |
| Canada goose | *Branta canadensis* |
| osprey | *Pandion haliaetus* |
| bald eagle | *Haliaeetus leucocephalus* |
| barred owl (heard) | *Strix varia* |
| fly-catcher | *Tyrannidae* |
| winter wren | *Troglodytes troglodytes* |
| broadwing hawk | *Buteo platypterus* |
| common raven | *Corvus corax* |
| black-throated blue warbler | *Dendroica caerulescens* |
| chestnut-sided warbler | *Dendroica pensylvanica* |
| American bittern | *Botaurus lentiginosus* |
| black-backed woodpecker | *Picoides arcticus* |
| veery | *Catharus fuscescens* |
| evening grosbeak | *Coccothraustes vespertinus* |
| hermit thrush | *Catharus guttatus* |
| ovenbird | *Seiurus aurocapillus* |
| pileated woodpecker | *Dryocopus pileatus* |
| downy woodpecker | *Picoides pubescens* |
| swamp sparrow | *Melospiza georgiana* |
| pine grosbeak | *Pinicola enucleator* |
| **Insect** | |
| water strider | *O: Hemiptera F: Gerridae* |
| predacious diving beetle | *O: Coleoptera F: Dytiscidae* |
| damsel fly | *O: Odonata S.O.: Zygoptera* |
| mosquitoes | *O: Diptera F: Culicidae* |
| black-flies (adult and larvae) | *O: Diptera F: Simuliidae* |
| deer flies | *O: Diptera F: Tabanidae* |
| *Anthophylax cyaneus* | *O: Coleoptera F: Cerambycidae* |
| *Liogma nodicornis* | *O: Endopterygota* |
| ebony jewelwing | *Calopteryx maculata* |
| caddis fly larvae-leaf cases | *O: Trichoptera* |
| caddis fly larvae-sand cases | *O: Trichoptera* |
| fairy shrimp[1] | *O: Anostraca* |
| whirlygig beetle | *O: Coleoptera F: Gyrindae* |
| fishfly | *O: Megaloptera F: Corydalidae* |
| stone fly | *O: Plecoptera F: Taeniopterygidae* |

[1]Fairy shrimp were not observed within the project area addressed under this amendment, but were observed in two vernal pools within the adjacent Oakfield I project area.

# Appendix 7-4
# Fall 2007 Bat Migration Survey Report for the Oakfield Wind Project, Oakfield, Maine

# Fall 2007 Bat Migration Survey Report

## Acoustic Bat Surveys for the Oakfield Wind Project
## In Oakfield, Maine

Prepared for

UPC Wind Management, LLC
1 Dana Street, 2nd Floor
Portland, ME 04101

Prepared by

Stantec Consulting
(formerly Woodlot Alternatives, Inc.)
30 Park Drive
Topsham, ME 04086

July 2008

FINAL

# Executive Summary

During fall 2007, Stantec Consulting (Stantec), formerly Woodlot Alternatives, Inc. (Woodlot)[1], conducted field surveys of bat migration activity at the Oakfield wind project area in Oakfield, Maine. The surveys are part of the planning process by UPC Wind Management, LLC (UPC) for a proposed wind project (Project). These surveys represented the first season of investigation undertaken at this site.

The results of the field surveys provide useful information about site-specific migration activity and patterns in the vicinity of the Project area, including species composition and timing.

*Bat Survey*

The 2007 field survey included documentation of fall bat activity through passive surveys with four acoustic detectors deployed in trees, resulting in 265 detector-nights of recordings from August 2 thru November 1. Four detectors were initially deployed in trees in the Project area; however, two detectors were moved to the meteorological tower after it was erected in late September. A total of 1,082 bat call sequences were recorded during the fall sampling period. The mean detection rate of all detectors was 4.1 detections per detector-night. The detection rate was generally similar to results of other fall surveys deployed in trees in Maine and the region. Habitat, landscape, location, and survey effort may account for the observed differences.

Bat calls were identified to the lowest possible taxonomic level. These were then grouped into four guilds based on similarity in call characteristics between some species and the inability of detectors to adequately and reliably distinguish between other species. The majority of calls (51%) were identified as *Myotis*, followed by unknown calls that could not be identified to guild (46%). Fewer than one percent of calls were identified as big brown guild or as eastern pipistrelle/red bat guild. This trend in species composition is similar to that of other studies in the region.

[1] All field work and any reporting and permitting activities performed prior to October 1, 2007, were conducted as Woodlot Alternatives, Inc. and will be herein referenced as work done by Woodlot. On October 1, 2007, Woodlot Alternatives, Inc. was acquired by Stantec Consulting Services, Inc. Work conducted on or after October 1, 2007, is herein referenced as work done by Stantec.

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PN195600152/107217

# 1.0 Introduction

This report has been prepared to provide a summary of the results of the fall acoustic detector surveys conducted in the Oakfield project area, including activity patterns and species composition.

Following is a brief description of the project; a review of the methods used to conduct scientific surveys and the results of those surveys; a discussion of those results; and the conclusions reached based on those results.

## 1.1 PROJECT CONTEXT

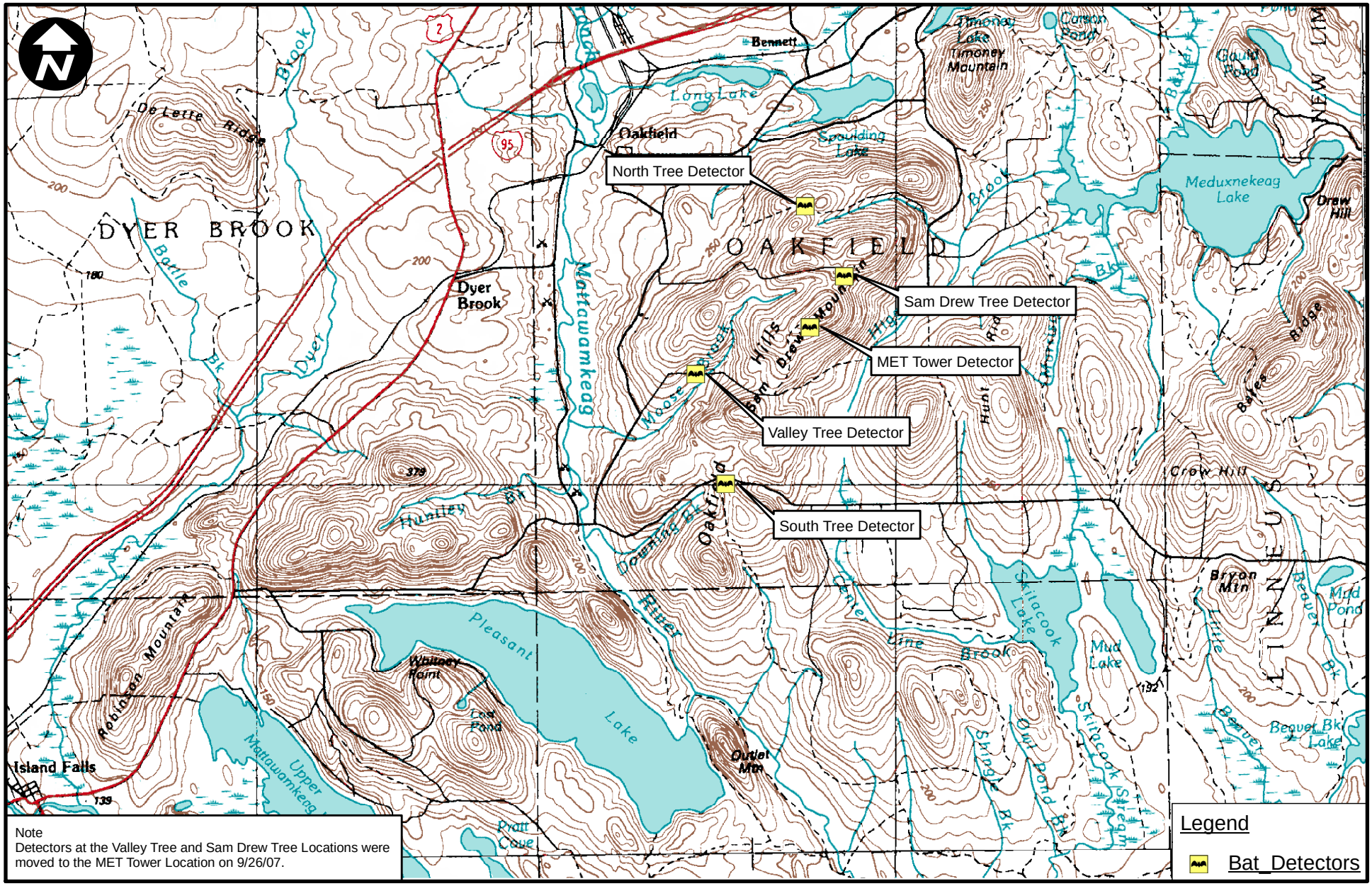
UPC Wind Management, LLC (UPC) has proposed construction of a wind project located in Oakfield in Aroostook County, Maine (Figure 1-1). The project is still in the preliminary stages of design, but is expected to consist of 20 to 30 turbines in the Oakfield Hills and an electrical transmission line that will connect to an existing electrical power line that is located near the town of Linneus, Maine (Project).

In advance of permitting activities for this project, UPC contracted Stantec Consulting, (Stantec) formerly Woodlot Alternatives, Inc.[2], to conduct acoustic detector surveys to determine the presence and, when possible, species composition of bats in the Project area during the fall migration period. The surveys will provide data to help assess the potential risk to bats from the proposed Project. The scope of the bat surveys was based on a combination of standard methods that are developing within the wind power industry for pre-construction surveys and is consistent with several other studies conducted recently in Maine and throughout the Northeast region of the United States.

## 1.2 PROJECT AREA DESCRIPTION

The Project area is situated in the town of Oakfield, Aroostook County, Maine. In general, the majority of the landscape is a transition zone with two dominant land uses characteristic of unorganized townships in northeastern Maine - agriculture and commercial timber management. Timber management has traditionally occurred along most of the two ridges and active agriculture occurs at lower elevations where favorable soils occur, and several seasonal camps are located intermittently near existing gravel roads (Figure 1-1).

[2] On October 1, 2007, Woodlot Alternatives, Inc. was formally acquired by Stantec Consulting Services, Inc.




Note
Detectors at the Valley Tree and Sam Drew Tree Locations were moved to the MET Tower Location on 9/26/07.

Prepared By:

Stantec

WOODLOT

107217-F101-Bat.mxd

Sheet Title:

*Bat Detector Location Map*

Project:

*Oakfield Wind Project*
*Oakfield, Maine*

0 7,000 Feet

Date: Jan. 9, 2008

Scale: 1" = 7000'

Proj. No.: 195600152

Figure:

*1.1*

The Project area is located within the Aroostook Hills and Lowlands Ecoregion of Maine, one of the eight regions identified in Maine's Comprehensive Wildlife Conservation Strategy (MDIFW 2005). Various areas of theses state ecoregions were previously delineated and characterized by McMahon (1990) based on areas demonstrating similar climate, soils, topography, and vegetation.

The Aroostook Hills and Lowlands Ecoregion is an area of approximately 2.5 million acres that is characterized by its calcareous soils and predominance of bedrock in the hills, while deep loams provide the basis for a large agricultural land use in the lowlands. The region also serves as the transition from temperate northern forests to the boreal spruce-fir forests that occur to the north and throughout Canada. Approximately half of the area is owned by commercial timber management companies in unorganized townships. Overall the region remains sparsely populated compared to areas in central and southern Maine.

A variation of the naturally occurring Beech – Birch – Maple Forest is the dominant forest community in the Project area. This type of Northern Hardwood Forest occurs in rich soils, under a closed canopy (in natural conditions), and includes a combination of American beech (*Fagus grandifolia*), yellow birch (*Betula alleghaniensis*), and sugar maple (*Acer saccharum*) as dominant canopy species. The percent coverage of the dominant canopy species varies along the ridgelines, particularly as a result of the timber management activities treatments. A variation of the Spruce – Northern Hardwoods Forest community also occurs in the project area. Dominant canopy trees include red spruce (*Picea rubens*), yellow birch, and other hardwood species including beech and sugar maple. Examples of this community variation occur along the northern and southern ridgeline of Oakfield Hills. Hunt Ridge may include a similar community variation or include other spruce-fir communities.

# 2.0 Acoustic Bat Survey

A total of eight species of bats are recognized to occur in Maine, based upon their normal geographical range. These are the little brown bat (*Myotis lucifugus*), northern long-eared bat (*M. septentrionalis*), eastern small-footed bat (*M. leibii*), silver-haired bat (*Lasionycteris noctivagans*), eastern pipistrelle (*Pipistrellus subflavus*), big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), and hoary bat (*L. cinereus*) (Whitaker and Hamilton 1998). All eight species are listed as species of Special Concern in Maine due to a lack of information on population size and trends. All but the eastern small-footed bat are believed to occur in most of the state; the eastern small-footed bat is believed to be rare, but population size and trends are not well known for this species.

## 2.1 INTRODUCTION

Stantec conducted acoustic monitoring surveys with Anabat detectors during fall 2007. Acoustic bat detectors allow for long-term monitoring of activity patterns of bats in a variety of habitats, including the air space approaching the rotor-swept zone of modern wind turbines. The

acoustic bat survey at Oakfield was designed to document bat activity patterns near the rotor zone of the proposed turbines, at an intermediate height, and near the ground. Because meteorological towers were not installed until late September, detectors were deployed in trees and then moved to the tower during the course of the seasonal survey; results for tree and tower detectors are reported separately. Acoustic surveys were also intended to document bat activity patterns in relation to local temperature and humidity levels.

## 2.2 METHODS

### 2.2.1 Field Surveys

Anabat II detectors (Titley Electronics Pty Ltd.) were used for the duration of the fall 2007 acoustic bat survey. Each Anabat detector was coupled with CF Storage ZCAIM (Titley Electronics Pty Ltd.), which programmed the on/off times and stored data on removable 1 GB compact flash cards. Anabat detectors are frequency division detectors, dividing the frequency of ultrasonic calls made by bats by a factor of 16 so that they are audible to humans, and recording the bat calls for subsequent analysis. Anabat detectors were selected based upon their widespread use for this type of survey, their ability to be deployed for long periods of time, and their ability to detect a broad frequency range, which allows detection of all species of bats that could occur in the Project area.

Four detectors were deployed within the project area between early August and November 1, and programmed to record data continuously between 7:00 pm and 7:00 am each night. Detectors were powered by 12-volt batteries charged by solar panels. Because met towers were not deployed until late September, detectors were initially deployed in trees at heights of 3 meters (m; 10 feet ['']) to 6 m (20'), and then two detectors were moved to the tower at heights of 10 m (32') to 15 m (65') on September 25 (Figure 1-1).

Each solar-powered Anabat system was deployed in a waterproof housing enabling the detector to record while unattended for the duration of the survey. The housing suspends the Anabat microphone downward to give maximum protection from precipitation. To compensate for the downward position, a reflector shield of smooth plastic is placed at a 45-degree angle directly below the microphone. The angled reflector allows the microphone to record the airspace horizontally surrounding the detector and is only slightly less sensitive than an unmodified Anabat unit.

Maintenance visits were conducted approximately every one to two weeks to check on the condition of the detectors and download data to a computer for analysis. The sensitivity of each Anabat system was set at between six and seven to maximize sensitivity while limiting ambient background noise and interference. The sensitivity of individual detectors was tested using an ultrasonic Bat Chirp (Reno, NV) to ensure that the detectors would be able to detect bats up to a distance of at least 10 m (33').

### 2.2.2 Data Analysis

Potential call files were extracted from data files using CFCread© software. The default settings for CFCread© were used during this file extraction process, as these settings are recommended for the calls that are characteristic of northeastern bats. This software screens all data recorded by the bat detector and extracts call files using a filter. Using the default settings for this initial screen also ensures comparability between data sets. Settings used by the filter include a max TBC (time between calls) of 5 seconds, a minimum line length of 5 milliseconds, and a smoothing factor of 50. The smoothing factor refers to whether or not adjacent pixels can be connected with a smooth line. The higher the smoothing factor, the less restrictive the filter is and the more noise files and poor quality call sequences are retained within the data set. A call is a single pulse of sound produced by a bat. A call sequence is a combination of two or more pulses recorded in a call file. Understanding these parameters is important in understanding when species identification are termed “unknown”.

Following extraction of call files, each file was visually inspected to ensure that files created by static or some other form of interference that were still within the frequency range of northeastern bats were not included in the data set. Call sequences were identified based on visual comparison of call sequences to reference calls provided by Chris Corben, developer of the Anabat system, and nationally-recognized bat expert Lynn Robbins. Bat calls typically include a series of pulses characteristic of normal flight or prey location (“search phase” calls) and capture periods (feeding “buzzes”) and visually look very different than static, which typically forms a diffuse band of dots at either a constant frequency or widely varying frequency, caused by wind, vibration, or other interference. Using these characteristics, bat call files are easily distinguished from non-bat files.

Bat call sequences were individually marked and categorized by species group, or “guild” based on visual comparison to reference calls. Qualitative visual comparison of recorded call sequences of sufficient length to reference libraries of bat calls allows for relatively accurate identification of bat species (O’Farrell *et al*. 1999, O’Farrell and Gannon 1999). A call sequence was considered of suitable quality and duration if the individual call pulses were “clean” (i.e., consisting of sharp, distinct lines) and at least five pulses were included within the sequence. Call sequences were classified to species whenever possible, using the reference calls described above. However, due to similarity of call signatures between several species, all classified calls have been categorized into four guilds for presentation in this report. This classification scheme follows that of Gannon *et al.* (2003) and is as follows:

- **Unknown (UNKN)** – all call sequences with too few pulses (less than five) or of poor quality (such as indistinct pulse characteristics or background static). These calls were further identified as either “high frequency unknown” (HFUN) for calls above 35 kHz or “low frequency unknown” (LFUN) for calls below 35 kHz;

- **Myotid (MYSP)** – All bats of the genus *Myotis*. While there are some general characteristics believed to be distinctive for several of the species in this genus, these

characteristics do not occur consistently enough for any one species to be relied upon at all times when using Anabat recordings;

- **Red bat/pipistrelle (RBEP)** – Eastern red bats and eastern pipistrelles. Like many of the other northeastern bats, these two species can produce calls distinctive only to each species. However, significant overlap in the call pulse shape, frequency range, and slope can also occur. Evening bats would also be included in this guild, and;

- **Big brown/silver-haired/hoary bat (BBSHHB)** – This guild will be referred to as the big brown guild. These species' call signatures commonly overlap and have therefore been included as one guild in this report.

This guild grouping represents the most conservative approach to bat call identification (Hayes 2000). Since some species do sometimes produce calls unique only to that species, all calls were identified to the lowest possible taxonomic level before being grouped into the listed guilds. Tables and figures in the body of this report will reflect those guilds. However, since species-specific identification did occur in some cases, each guild will also be briefly discussed with respect to potential species composition of recorded call sequences.

Once all of the call files were identified and categorized in appropriate guilds, nightly tallies of detected calls were compiled. Mean detection rates (number of calls/detector-night) for the entire sampling period were calculated for each detector and for all detectors combined. It is important to note that detection rates indicate only the number of calls detected and do not necessarily reflect the number of individual bats in an area. For example, a single individual can produce one or many call files recorded by the bat detector, but the bat detector cannot differentiate between individuals of the same species producing those calls. Consequently, detections recorded by the bat detector system likely over-represent the actual number of animals that produced the recorded calls.

### 2.2.3 Weather Data

Temperature and humidity data were recorded from August 20 to October 31 at 10-minute intervals by data loggers (HOBO Pro v2 U23-001, Onset Computer Corporation) placed on at least one of the bat detector systems. The mean, maximum, and minimum temperatures and humidity were calculated for each night.

## 2.3 RESULTS

### 2.3.1 Detector Call Analysis

Detectors were deployed on August 2 and continued to record data through November 1, for a total survey period of up to 79 nights per detector. The range of dates that each detector was deployed is summarized in Table 2-1. Occasional data gaps occurred when certain detectors powered down during the survey period. To account for these periods, the number of detector-nights is reported for each detector. Combined, the four detectors deployed at Oakfield sampled a total of 265 detector-nights during the fall survey period.

A total of 1,082 bat call sequences were recorded during the sampling period (Table 2-1). The number of call sequences recorded by each detector ranged from 0 at the Met Low detector to 456 at the Valley Tree detector. The overall mean detection rate for all four detectors deployed in trees was 4.1 calls/detector-night. No calls were recorded by the detectors deployed in the tower after September 26. Detection rates at each of the tree detectors ranged from 1.8 calls/detector-night at the North Tree detector to 10.6 calls/detector-night at the Valley Tree detector. The maximum number of call sequences recorded in one night ranged from 8 at the North Tree detector to 58 at the Valley Tree detector.

**Table 2-1.** Summary of bat detector field survey effort and results

| Location | Dates | # Detector-Nights* | # Recorded sequences | Detection Rate ** | Maximum # calls recorded *** |
|---|---|---|---|---|---|
| South Tree | 8/2 - 9/11, 9/26 - 11/1 | 78 | 346 | 4.4 | 28 |
| North Tree | 8/2 - 8/18, 8/22 - 9/25 | 52 | 93 | 1.8 | 8 |
| Sam Drew Tree | 8/2 - 9/25 | 55 | 187 | 3.4 | 29 |
| Valley Tree | 8/2 - 9/25 | 43 | 456 | 10.6 | 58 |
| Met High | 9/26 - 11/1 | 37 | 0 | 0.0 | 0 |
| Met Low | 9/26 - 11/1 | 0 | 0 | 0.0 | 0 |
| ***Overall Results*** | | ***265*** | ***1082*** | ***4.1*** | -- |

* Detector-night is a sampling unit during which a single detector is deployed overnight. On nights when two detectors are deployed, the sampling effort equals two detector-nights, etc.

** Number of bat passes recorded per detector-night.

*** Maximum number of bat passes recorded from any **single** detector for a 12-hour sampling period.

Appendix A provides a series of tables with more specific information on the nightly timing, number, and species composition of recorded bat call sequences. Specifically, Appendix A Tables 1 through 6 provide information on the number of call sequences, by guild and suspected species, recorded at each detector and the weather conditions for that night. Upon request, Stantec can provide a spreadsheet identifying the the Analook file name for all 1,082 recorded call sequences, the night during which the call sequence was recorded, the timing of the recording, and the suspected identity of the species recorded.

Overall, peak numbers of call sequences were recorded at Oakfield in early August (Figure 2-1). Individually, all four tree detectors recorded peak levels of calls during this same time span, but two detectors had additional peaks: the South Tree detector had a smaller peak in late August, and the Valley Tree detector had a smaller peak in early and late September. Since neither of

these two detectors ever recorded more than 42 calls in one night during these peaks, the effect of these two additional peaks is minimal when all activity is taken into account. Overall, all four detectors had a nightly peak in activity between 10:00 and 11:00 pm (Figure 2-2). These peaks in overall activity were consistent at an individual detector level.

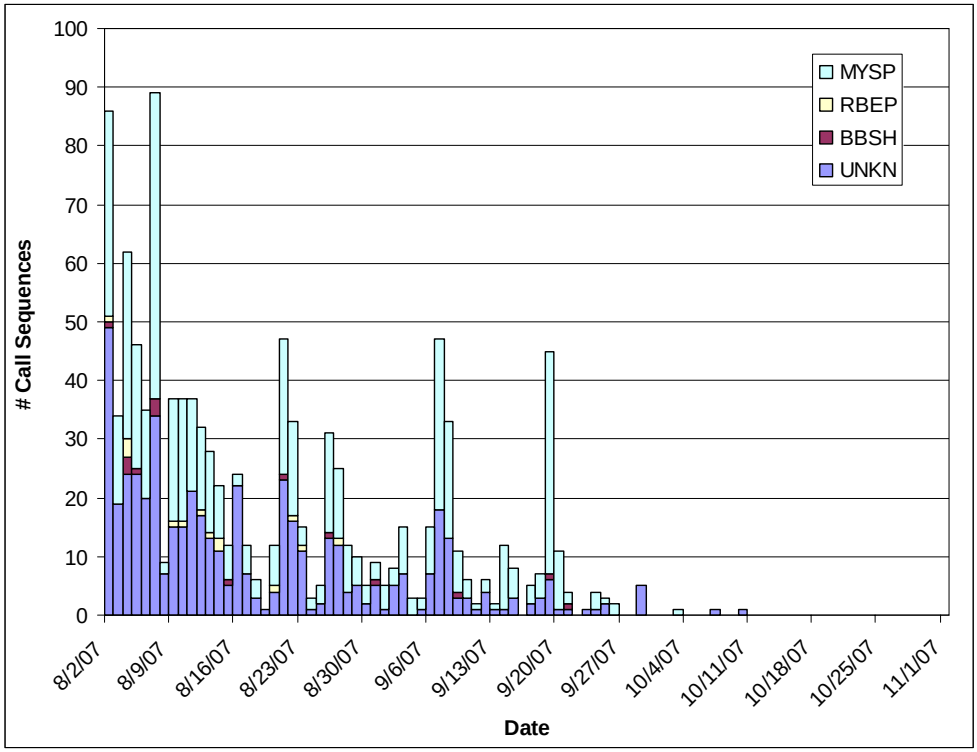



**Figure 2-1.** Total nightly bat call sequence detections for all detectors deployed during fall 2007

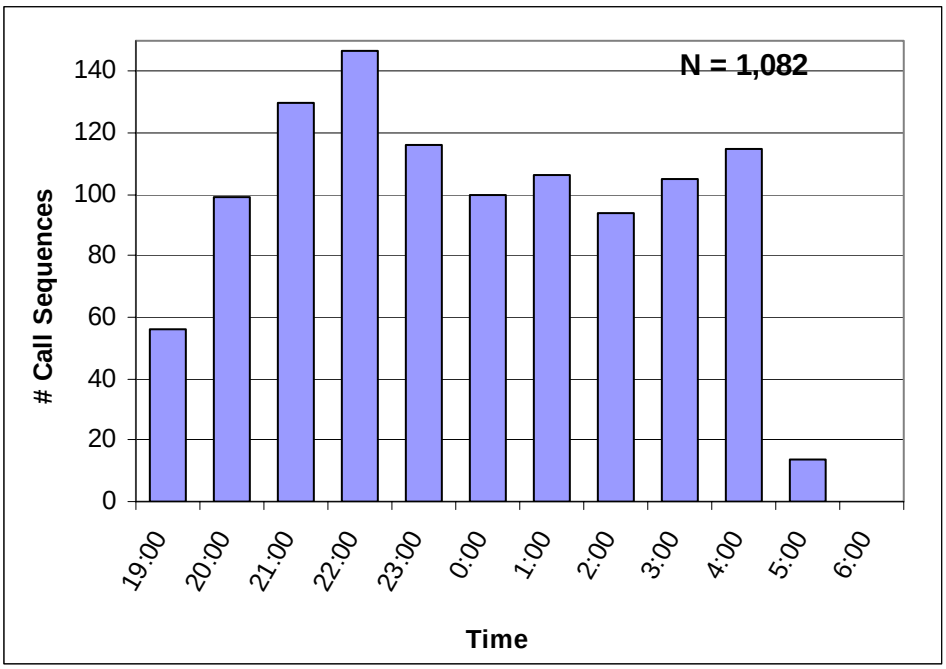



**Figure 2-2.** Nightly timing of recorded bat activity for all detectors deployed during fall 2007

Some of the recorded call sequences (46%) were labeled as unknown due to very short call sequences (less than seven pulses) or poor call signature formation (probably due to a bat flying at the edge of the detection zone of the detector or flying away from the microphone) (Table 2-2). Of all the calls that were identified to species or guild, those of the MYSP guild were the most common (51% of all call sequences), followed by the species within the BBSHHB guild (1% of all call sequences) and species within the red bat/eastern pipistrelle guild (1% of all call sequences).

**Table 2-2.** Summary of the composition of recorded bat call sequences.

| Detector | Guild | | | | Total |
|---|---|---|---|---|---|
| | Big brown guild | Red bat/ E. pipistrelle | Myotis | Unknown | |
| South Tree | 4 | 6 | 226 | 110 | 346 |
| North Tree | 4 | 2 | 47 | 40 | 93 |
| Sam Drew Tree | 7 | 6 | 74 | 100 | 187 |
| Valley Tree | 0 | 0 | 209 | 247 | 456 |
| Met High | 0 | 0 | 0 | 0 | 0 |
| Met Low | 0 | 0 | 0 | 0 | 0 |
| ***Total*** | ***15*** | ***14*** | ***556*** | ***497*** | ***1,082*** |

Of the calls recorded at each detector identified to guild, those of the MYSP guild were the most common, and in most cases made up more than 40 percent of all calls. The RBEP guild made up the least number of calls recorded. At each detector, calls within the UNKN group made up approximately a third to half of all calls recorded.

### 2.3.2 Weather Data

Weather data is available for a portion of the survey period when dataloggers were deployed.

Mean nightly temperatures in the Project area from August 20 to October 31 varied between -1.1 and 21.8 degrees Celsius (°C; 34 and 71.2 degrees Fahrenheit [°F]) with an overall mean of 10.6 °C (51.1 °F). Total nightly bat call volumes were slightly positively correlated with mean nightly temperature (r=0.387) (Figure 2-3).

Mean nightly humidity in the Project area from August 20 to October 31 varied between 43.1 and 99.1 percent with an overall mean of 79 percent. Total nightly bat call volumes were negatively correlated with mean nightly humidity (r=-0.134) (Figure 2-4).

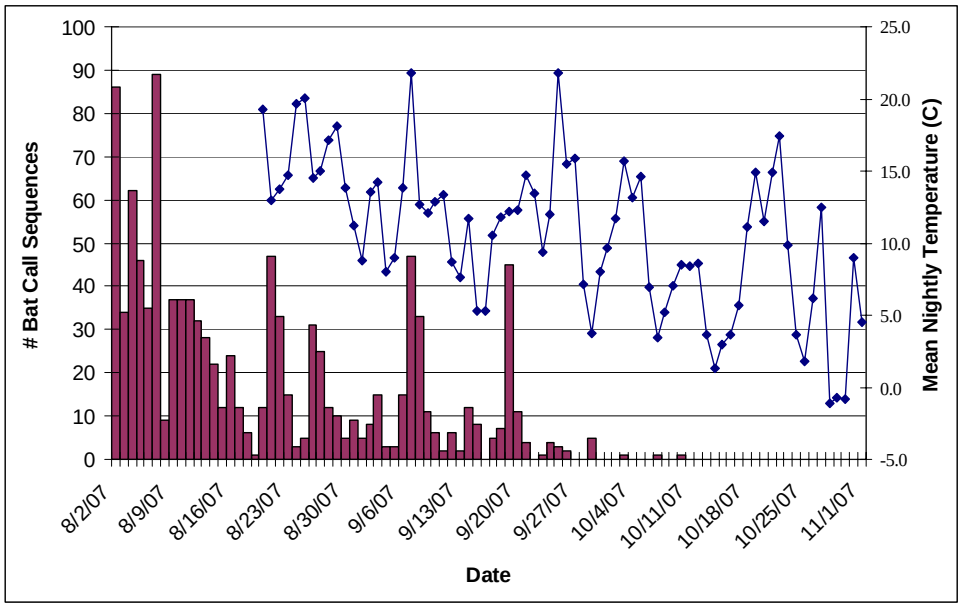



**Figure 2-3.** Relationship between mean nightly temperature and combined nightly bat call volume

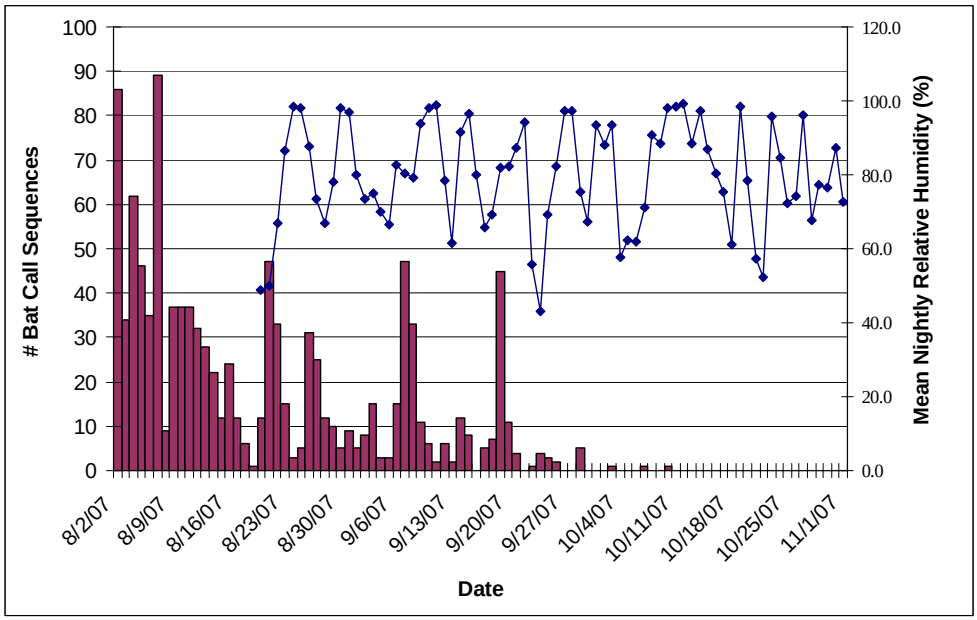



**Figure 2-4.** Relationship between mean nightly humidity and combined nightly bat call volume

## 2.4 DISCUSSION

Bat echolocation surveys in fall 2007 provide some insight into activity patterns, possible species composition, and timing of movements of bats in the Project area. Bat activity was variable among nights at all six acoustic sampling locations. Peak call sequence detections occurred during the first two weeks in August, with some individual detectors recording isolated peaks in late August and mid September. Overall nightly activity peaked at 10:00 pm, and seems to correlate with temperature. All detectors deployed in trees recorded bats belonging to all four guilds, except for the Valley Tree detector which did not record any sequences belonging to the BBSHHB or RBEP guild. Detectors deployed in the met tower from late September through October did not record any bat call sequences. The overall mean detection rate during the fall survey period was 4.1 calls/detector-night.

Bat calls were identified to guild within this report, although calls were provisionally categorized by species when possible during analysis. Certain species, such as the eastern red bat and hoary bat have easily identifiable calls, whereas other species, such as the big brown bat and silver-haired bat are difficult to distinguish acoustically. Similarly, certain members of the *Myotis* genus, such as the little brown bat, are far more common and have slightly more distinguishable calls than other species. The following paragraphs discuss each guild separately and address likely species composition of recorded bats within each guild.

The MYSP guild includes all three species of *Myotis* potentially occurring in the Project area, including the little brown bat, northern long-eared bat, and the eastern small-footed bat. Of these species, the little brown bat and northern long-eared bat are by far the most common, and have calls that tend to be slightly more distinguishable using the Anabat system. Calls in the MYSP guild were identified at all four detectors at Oakfield, 51 percent (n = 556) of all calls.

Species in the genus *Myotis* tend to fly lower and forage in more forested areas than other bat species in the area, so it is not surprising that all four detectors, which were suspended in trees, detected MYSP calls. Detectors placed close to the ground may record ground interference from other high frequency sound producers such as insects. In addition, detectors placed within forested areas often record interference produced as wind blows through vegetation. Given that distinguishing calls among species in the MYSP guild requires detecting very subtle differences in call structure, and that most of the MYSP calls at Oakfield were recorded in areas with varying degrees of interference, it is difficult to say which species within the guild have been recorded.

The BBSHHB guild includes the big brown bat, silver-haired bat, and hoary bat. Within this grouping, the hoary bat has easily distinguishable calls characterized by highly variable minimum frequencies often extending below 20 kHz, and a hooked profile similar to the eastern red bat. Calls of silver-haired bats and big brown bats are occasionally distinguishable, but often overlap in range and can be difficult to distinguish, especially when comparing short duration calls typical of those recorded during passive monitoring. Of the 15 calls classified as BBSHHB, 47 percent (n = 7) were recorded at the Sam Drew Tree detector, 27 percent at both the North Tree detector (n = 4) and at the South Tree detector (n = 4). None of the files recorded by the Valley Tree detector were classified as BBSHHB calls; however, low frequency unknown calls recorded by this detector could potentially belong to this group. Species within the BBSHHB guild generally fly higher than other species and forage in more open habitat, so it's not surprising that BBSHHB call sequences made up only 1 percent of all recorded files.

The RBEP guild includes the eastern pipistrelle and eastern red bat. Eastern red bats have relatively unique calls which span a wide range of frequency and have a characteristic hooked shape and variable minimum frequency. Eastern pipistrelles tend to have relatively uniform calls, with a constant minimum frequency and a sharply curved profile. Of the 14 calls classified as RBEP, 43 percent (n = 6) were recorded at the South Tree detector and at the Sam Drew Tree detector, and 14 percent (n = 2) were recorded at the North Tree detector. None of the files recorded by the Valley Tree detector were classified as RBEP calls; however, high frequency unknown calls recorded by this detector could potentially belong to this group. Overall, RBEP call sequences made up only 1 percent of all recorded files

Of the 1,082 total calls recorded at Oakfield, 497, or 46 percent, were classified as UNKN, due to their short duration or poor quality. However, these calls were identified as "high frequency" or "low frequency". For the purposes of this analysis, "high frequency" call fragments were defined as having a minimum frequency above 30 kHz, and "low frequency" calls were defined as having a minimum frequency below 30 kHz. Most (82%) of UNKN calls were identified as high frequency unknown (HFUN). These calls could potentially belong to either the MYSP or RBEP guilds. Given the large number of MYSP files recorded, most of the HFUN files are likely MYSP calls. This is reinforced by analysis notes indicating that most files identified as HFUN were thought to be short duration or low quality MYSP files.

Differences in detection rates between guilds at the various detectors deployed in the Project area may reflect varying vertical distribution and habitat preferences of bat species (Hayes

2000). Recent research (Arnett *et al*. 2006) found that small *Myotis* species were more frequently recorded at lower heights while larger species were typically recorded more often at higher heights. In forested habitat, both large and small species were recorded in greater numbers at a medium height of 22 m (72'), rather than at 1.5 m or 44 m (5 or 144'). At Oakfield, all detectors were in trees for most of the survey period and were placed at heights of approximately 3-6 m (9-19'). Species diversity was relatively consistent among all detectors.

Bat activity patterns during migration seem to be related to weather conditions based on mortality studies and acoustic surveys. Acoustic surveys have documented a decrease in bat activity rates as wind speeds increase and temperatures decrease, and bat activity has been shown to correlate negatively to low nightly mean temperatures (Hayes 1997, Reynolds 2006). Similarly, weather factors appeared related to bat collision mortality rates documented at two facilities in the southeastern United States, with mortality rates negatively correlated with both wind speed and relative humidity, and positively correlated to barometric pressure (Arnett 2005). These patterns suggest that bats are more likely to migrate on nights with low wind speeds (less than 4-6 m/s) and generally favorable weather (warm temperatures, low humidity, high barometric pressure). Similarly, bat activity at Oakfield seems to be positively correlated with mean nightly temperature and negatively correlated with mean nightly humidity.

Bat activity also appeared to vary by time of night, with peaks in activity occurring soon after dusk and before dawn. This bimodal nighttime distribution of bat activity documented at both met towers seems to be a consistent behavioral trend in a number of species (Hayes 1997). Anthony *et al*. (1981) documented that bats appear to leave roosting sites at dusk to forage for a given period, return to their roosts during the middle portion of the night, then forage again later in the evening, closer to dawn. However, patterns other than bimodal could be observed because considerable variation can occur within nights (Hayes, 1997). One peak of activity was observed at Oakfield, at 10:00 pm.

Results of acoustic surveys must be interpreted with caution. Considerable room for error exists in identification of bats based upon acoustic calls alone, especially if a site or regionally specific library of recorded reference calls is not available. Also, detection rates are not necessarily correlated with the actual numbers of bats in an area, because it is not possible to differentiate between individual bats (Hayes 2000).

## 2.5 CONCLUSIONS

Acoustic bat surveys documented bat activity in the project area between early August and late October. Species composition was fairly consistent between detectors, with *Myotids* comprising the majority of call sequences recorded by all the detectors identified to guild. Activity levels were positively correlated with temperature on a nightly basis. No sequences were recorded when the detectors were deployed in the tower during late September and through October.

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# Appendix A

Bat survey results

**FALL 2007 BAT MIGRATION SURVEY**
Proposed Oakfield Wind Project
July 2008

**Appendix A Table 1**. Summary of acoustic bat data and weather during each survey night at the South Tree detector – Fall 2007

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Night of | Operated Okay? | big brown bat | hoary bat | silver-haired bat | silver-haired/big brown | eastern pipistrelle | eastern red bat | pipistrelle/red bat | MYSP | high-frequency | low-frequency | unknown | Total | Relative Humidity (%) | Temperature (celsius) |
| 8/2/07 | y | | | | | | | | 10 | 4 | | | **14** | | |
| 8/3/07 | y | | | | | | | | 5 | 1 | | | **6** | | |
| 8/4/07 | y | | | | 1 | | 1 | | 20 | 4 | | | **26** | | |
| 8/5/07 | y | | | | | | | | 15 | 4 | 1 | | **20** | | |
| 8/6/07 | y | | | | | | | | 7 | 1 | | | **8** | | |
| 8/7/07 | y | | | | 1 | | | | 12 | 4 | | | **17** | | |
| 8/8/07 | y | | | | | | | | 1 | | 2 | | **3** | | |
| 8/9/07 | y | | | | | | | | 15 | 4 | | | **19** | | |
| 8/10/07 | y | | | | | | | | 11 | 4 | | | **15** | | |
| 8/11/07 | y | | | | | | | | 9 | 1 | | | **10** | | |
| 8/12/07 | y | | | | | | | 1 | 4 | 1 | | | **6** | | |
| 8/13/07 | y | | | | | | 1 | | 12 | 5 | | | **18** | | |
| 8/14/07 | y | | | | | | | | 6 | 3 | | | **9** | | |
| 8/15/07 | y | | | | 1 | | | | 5 | 2 | | | **8** | | |
| 8/16/07 | y | | | | | | | | | 2 | 1 | | **3** | | |
| 8/17/07 | y | | | | | | | | 4 | 1 | | | **5** | | |
| 8/18/07 | y | | | | | | | | 3 | 1 | | | **4** | | |
| 8/19/07 | y | | | | | | | | | 1 | | | **1** | | |
| 8/20/07 | y | | | | | 1 | | | 6 | 1 | | | **8** | 48.8 | 19.3 |
| 8/21/07 | y | | | | | | | | 18 | 10 | | | **28** | 50.0 | 13.0 |
| 8/22/07 | y | | | | | | | | 5 | 5 | | | **10** | 66.9 | 13.8 |
| 8/23/07 | y | | | | | | | 1 | 2 | 3 | 5 | 1 | **12** | 86.7 | 14.7 |
| 8/24/07 | y | | | | | | | | 2 | 1 | | | **3** | 98.6 | 19.7 |
| 8/25/07 | y | | | | | | | | 2 | 1 | | | **3** | 98.3 | 20.1 |
| 8/26/07 | y | | | | | | | | 11 | 7 | | | **18** | 87.9 | 14.5 |
| 8/27/07 | y | | | | | | | 1 | 8 | 6 | 1 | | **16** | 73.6 | 15.0 |
| 8/28/07 | y | | | | | | | | 7 | 3 | | | **10** | 67.0 | 17.1 |
| 8/29/07 | y | | | | | | | | 5 | 2 | | | **7** | 78.0 | 18.1 |
| 8/30/07 | y | | | | | | | | 2 | 1 | 1 | | **4** | 98.2 | 13.8 |
| 8/31/07 | y | | | | 1 | | | | 2 | 1 | 1 | | **5** | 97.1 | 11.2 |
| 9/1/07 | y | | | | | | | | 4 | | | | **4** | 80.0 | 8.8 |
| 9/2/07 | y | | | | | | | | 3 | 3 | | | **6** | 73.4 | 13.5 |
| 9/3/07 | y | | | | | | | | 6 | 1 | 2 | | **9** | 74.9 | 14.2 |
| 9/4/07 | y | | | | | | | | 1 | | | | **1** | 69.9 | 8.0 |
| 9/5/07 | y | | | | | | | | | | | | **0** | 66.5 | 8.9 |
| 9/6/07 | y | | | | | | | | | | | | **0** | 82.8 | 13.8 |
| 9/7/07 | y | | | | | | | | | | | | **0** | 80.2 | 21.8 |
| 9/8/07 | y | | | | | | | | | | | | **0** | 79.3 | 12.7 |
| 9/9/07 | y | | | | | | | | | | | | **0** | 94.0 | 12.1 |
| 9/10/07 | y | | | | | | | | | | | | **0** | 98.1 | 12.8 |
| 9/11/07 | y | | | | | | | | | | | | **0** | 99.0 | 13.4 |
| 9/12/07 | n | | | | | | | | | | | | **n/o** | 78.5 | 8.7 |
| 9/13/07 | n | | | | | | | | | | | | **n/o** | 61.6 | 7.6 |
| 9/14/07 | n | | | | | | | | | | | | **n/o** | 91.4 | 11.7 |
| 9/15/07 | n | | | | | | | | | | | | **n/o** | 96.4 | 5.3 |
| 9/16/07 | n | | | | | | | | | | | | **n/o** | 80.0 | 5.3 |
| 9/17/07 | n | | | | | | | | | | | | **n/o** | 65.6 | 10.5 |
| 9/18/07 | n | | | | | | | | | | | | **n/o** | 69.1 | 11.8 |
| 9/19/07 | n | | | | | | | | | | | | **n/o** | 82.0 | 12.2 |
| 9/20/07 | n | | | | | | | | | | | | **n/o** | 82.2 | 12.2 |
| 9/21/07 | n | | | | | | | | | | | | **n/o** | 87.4 | 14.7 |
| 9/22/07 | n | | | | | | | | | | | | **n/o** | 94.4 | 13.5 |
| 9/23/07 | n | | | | | | | | | | | | **n/o** | 55.8 | 9.3 |
| 9/24/07 | n | | | | | | | | | | | | **n/o** | 43.1 | 12.0 |
| 9/25/07 | n | | | | | | | | | | | | **n/o** | 69.4 | 21.8 |
| 9/26/07 | y | | | | | | | | 2 | | | | **2** | 82.2 | 15.5 |
| 9/27/07 | y | | | | | | | | | | | | **0** | 97.2 | 15.9 |
| 9/28/07 | y | | | | | | | | | | | | **0** | 97.3 | 7.1 |
| 9/29/07 | y | | | | | | | | | 2 | 1 | 2 | **5** | 75.5 | 3.7 |
| 9/30/07 | y | | | | | | | | | | | | **0** | 67.3 | 8.0 |
| 10/1/07 | y | | | | | | | | | | | | **0** | 93.6 | 9.6 |
| 10/2/07 | y | | | | | | | | | | | | **0** | 87.9 | 11.7 |
| 10/3/07 | y | | | | | | | | 1 | | | | **1** | 93.6 | 15.7 |
| 10/4/07 | y | | | | | | | | | | | | **0** | 57.7 | 13.2 |
| 10/5/07 | y | | | | | | | | | | | | **0** | 62.2 | 14.6 |
| 10/6/07 | y | | | | | | | | | | | | **0** | 61.9 | 7.0 |
| 10/7/07 | y | | | | | | | | | | 1 | | **1** | 71.0 | 3.5 |
| 10/8/07 | y | | | | | | | | | | | | **0** | 90.7 | 5.2 |
| 10/9/07 | y | | | | | | | | | | | | **0** | 88.6 | 7.0 |
| 10/10/07 | y | | | | | | | | | | 1 | | **1** | 97.9 | 8.5 |
| 10/11/07 | y | | | | | | | | | | | | **0** | 98.5 | 8.4 |
| 10/12/07 | y | | | | | | | | | | | | **0** | 99.1 | 8.6 |
| 10/13/07 | y | | | | | | | | | | | | **0** | 88.3 | 3.6 |
| 10/14/07 | y | | | | | | | | | | | | **0** | 97.2 | 1.3 |
| 10/15/07 | y | | | | | | | | | | | | **0** | 86.8 | 2.9 |
| 10/16/07 | y | | | | | | | | | | | | **0** | 80.4 | 3.6 |
| 10/17/07 | y | | | | | | | | | | | | **0** | 75.3 | 5.7 |
| 10/18/07 | y | | | | | | | | | | | | **0** | 61.1 | 11.1 |
| 10/19/07 | y | | | | | | | | | | | | **0** | 98.4 | 14.9 |
| 10/20/07 | y | | | | | | | | | | | | **0** | 78.3 | 11.5 |
| 10/21/07 | y | | | | | | | | | | | | **0** | 57.2 | 14.9 |
| 10/22/07 | y | | | | | | | | | | | | **0** | 52.2 | 17.4 |
| 10/23/07 | y | | | | | | | | | | | | **0** | 95.9 | 9.8 |
| 10/24/07 | y | | | | | | | | | | | | **0** | 84.6 | 3.7 |
| 10/25/07 | y | | | | | | | | | | | | **0** | 72.2 | 1.8 |
| 10/26/07 | y | | | | | | | | | | | | **0** | 74.2 | 6.2 |
| 10/27/07 | y | | | | | | | | | | | | **0** | 96.1 | 12.4 |
| 10/28/07 | y | | | | | | | | | | | | **0** | 67.6 | -1.1 |
| 10/29/07 | y | | | | | | | | | | | | **0** | 77.1 | -0.7 |
| 10/30/07 | y | | | | | | | | | | | | **0** | 76.4 | -0.8 |
| 10/31/07 | y | | | | | | | | | | | | **0** | 87.2 | 9.0 |
| 11/1/07 | y | | | | | | | | | | | | | 72.6 | 4.5 |
| **By Species** | | **0** | **0** | **0** | 4 | 1 | 2 | 3 | 226 | 90 | 17 | 3 | **346** | | |
| **By Guild** | | **4** | | | | **6** | | | **226** | **110** | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | |

n/o - indicates that detector was not operating on that night

**FALL 2007 BAT MIGRATION SURVEY**
Proposed Oakfield Wind Project
July 2008

**Appendix A Table 2**. Summary of acoustic bat data and weather during each survey night at the North Tree detector – Fall 2007

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Night of | Operated Okay? | big brown bat | hoary bat | silver-haired bat | silver-haired/big brown | eastern pipistrelle | eastern red bat | pipistrelle/red bat | MYSP | high-frequency | low-frequency | unknown | Total | Relative Humidity (%) | Temperature (celsius) |
| 8/2/07 | y | | | | | | | 1 | 2 | 2 | | | **5** | | |
| 8/3/07 | y | | | | | | | | | | | | **0** | | |
| 8/4/07 | y | | | | | | | | 3 | 3 | | | **6** | | |
| 8/5/07 | y | | | | | | | | 1 | | | | **1** | | |
| 8/6/07 | y | | | | | | | | 2 | | | | **2** | | |
| 8/7/07 | y | | | | 1 | | | | 2 | 1 | | | **4** | | |
| 8/8/07 | y | | | | | | | | | | | | **0** | | |
| 8/9/07 | y | | | | | | | | 4 | 4 | | | **8** | | |
| 8/10/07 | y | | | | | 1 | | | 2 | 1 | | | **4** | | |
| 8/11/07 | y | | | | | | | | 2 | 2 | | | **4** | | |
| 8/12/07 | y | | | | | | | | 1 | 2 | | | **3** | | |
| 8/13/07 | y | | | | | | | | | 1 | | | **1** | | |
| 8/14/07 | y | | | | | | | | | | | | **0** | | |
| 8/15/07 | y | | | | | | | | | | | | **0** | | |
| 8/16/07 | y | | | | | | | | | | | | **0** | | |
| 8/17/07 | y | | | | | | | | | | | | **0** | | |
| 8/18/07 | y | | | | | | | | | | | | **0** | | |
| 8/19/07 | n | | | | | | | | | | | | **n/o** | | |
| 8/20/07 | n | | | | | | | | | | | | **n/o** | 48.8 | 19.3 |
| 8/21/07 | n | | | | | | | | | | | | **n/o** | 50.0 | 13.0 |
| 8/22/07 | y | | | | | | | | | | | | **0** | 66.9 | 13.8 |
| 8/23/07 | y | | | | | | | | | 1 | | | **1** | 86.7 | 14.7 |
| 8/24/07 | y | | | | | | | | | | | | **0** | 98.6 | 19.7 |
| 8/25/07 | y | | | | | | | | | | | | **0** | 98.3 | 20.1 |
| 8/26/07 | y | | | | 1 | | | | 3 | 2 | | | **6** | 87.9 | 14.5 |
| 8/27/07 | y | | | | | | | | 2 | 1 | | | **3** | 73.6 | 15.0 |
| 8/28/07 | y | | | | | | | | | | | | **0** | 67.0 | 17.1 |
| 8/29/07 | y | | | | | | | | | | | | **0** | 78.0 | 18.1 |
| 8/30/07 | y | | | | | | | | 1 | | | | **1** | 98.2 | 13.8 |
| 8/31/07 | y | | | | | | | | 1 | 3 | | | **4** | 97.1 | 11.2 |
| 9/1/07 | y | | | | | | | | | 1 | | | **1** | 80.0 | 8.8 |
| 9/2/07 | y | | | | | | | | | 1 | | | **1** | 73.4 | 13.5 |
| 9/3/07 | y | | | | | | | | | | | | **0** | 74.9 | 14.2 |
| 9/4/07 | y | | | | | | | | 1 | | | | **1** | 69.9 | 8.0 |
| 9/5/07 | y | | | | | | | | 1 | | | | **1** | 66.5 | 8.9 |
| 9/6/07 | y | | | | | | | | 1 | 2 | | | **3** | 82.8 | 13.8 |
| 9/7/07 | y | | | | | | | | 2 | 3 | | 1 | **6** | 80.2 | 21.8 |
| 9/8/07 | y | | | | | | | | | 1 | | | **1** | 79.3 | 12.7 |
| 9/9/07 | y | | 1 | | | | | | 1 | 2 | | | **4** | 94.0 | 12.1 |
| 9/10/07 | y | | | | | | | | | | | | **0** | 98.1 | 12.8 |
| 9/11/07 | y | | | | | | | | | | | | **0** | 99.0 | 13.4 |
| 9/12/07 | y | | | | | | | | | | | | **0** | 78.5 | 8.7 |
| 9/13/07 | y | | | | | | | | | | | | **0** | 61.6 | 7.6 |
| 9/14/07 | y | | | | | | | | | | | | **0** | 91.4 | 11.7 |
| 9/15/07 | y | | | | | | | | 1 | | | | **1** | 96.4 | 5.3 |
| 9/16/07 | y | | | | | | | | | | | | **0** | 80.0 | 5.3 |
| 9/17/07 | y | | | | | | | | 3 | 1 | | | **4** | 65.6 | 10.5 |
| 9/18/07 | y | | | | | | | | 1 | 1 | | | **2** | 69.1 | 11.8 |
| 9/19/07 | y | | | | | | | | 1 | 1 | | | **2** | 82.0 | 12.2 |
| 9/20/07 | y | | | | | | | | 5 | 1 | | | **6** | 82.2 | 12.2 |
| 9/21/07 | y | | | | 1 | | | | 1 | | | | **2** | 87.4 | 14.7 |
| 9/22/07 | y | | | | | | | | | | | | **0** | 94.4 | 13.5 |
| 9/23/07 | y | | | | | | | | | | | | **0** | 55.8 | 9.3 |
| 9/24/07 | y | | | | | | | | 3 | | | | **3** | 43.1 | 12.0 |
| 9/25/07 | y | | | | | | | | | 2 | | | **2** | 69.4 | 21.8 |
| 9/26/07 | n | | | | | | | | | | | | **n/o** | 82.2 | 15.5 |
| 9/27/07 | n | | | | | | | | | | | | **n/o** | 97.2 | 15.9 |
| 9/28/07 | n | | | | | | | | | | | | **n/o** | 97.3 | 7.1 |
| 9/29/07 | n | | | | | | | | | | | | **n/o** | 75.5 | 3.7 |
| 9/30/07 | n | | | | | | | | | | | | **n/o** | 67.3 | 8.0 |
| 10/1/07 | n | | | | | | | | | | | | **n/o** | 93.6 | 9.6 |
| 10/2/07 | n | | | | | | | | | | | | **n/o** | 87.9 | 11.7 |
| 10/3/07 | n | | | | | | | | | | | | **n/o** | 93.6 | 15.7 |
| 10/4/07 | n | | | | | | | | | | | | **n/o** | 57.7 | 13.2 |
| 10/5/07 | n | | | | | | | | | | | | **n/o** | 62.2 | 14.6 |
| 10/6/07 | n | | | | | | | | | | | | **n/o** | 61.9 | 7.0 |
| 10/7/07 | n | | | | | | | | | | | | **n/o** | 71.0 | 3.5 |
| 10/8/07 | n | | | | | | | | | | | | **n/o** | 90.7 | 5.2 |
| 10/9/07 | n | | | | | | | | | | | | **n/o** | 88.6 | 7.0 |
| 10/10/07 | n | | | | | | | | | | | | **n/o** | 97.9 | 8.5 |
| 10/11/07 | n | | | | | | | | | | | | **n/o** | 98.5 | 8.4 |
| 10/12/07 | n | | | | | | | | | | | | **n/o** | 99.1 | 8.6 |
| 10/13/07 | n | | | | | | | | | | | | **n/o** | 88.3 | 3.6 |
| 10/14/07 | n | | | | | | | | | | | | **n/o** | 97.2 | 1.3 |
| 10/15/07 | n | | | | | | | | | | | | **n/o** | 86.8 | 2.9 |
| 10/16/07 | n | | | | | | | | | | | | **n/o** | 80.4 | 3.6 |
| 10/17/07 | n | | | | | | | | | | | | **n/o** | 75.3 | 5.7 |
| 10/18/07 | n | | | | | | | | | | | | **n/o** | 61.1 | 11.1 |
| 10/19/07 | n | | | | | | | | | | | | **n/o** | 98.4 | 14.9 |
| 10/20/07 | n | | | | | | | | | | | | **n/o** | 78.3 | 11.5 |
| 10/21/07 | n | | | | | | | | | | | | **n/o** | 57.2 | 14.9 |
| 10/22/07 | n | | | | | | | | | | | | **n/o** | 52.2 | 17.4 |
| 10/23/07 | n | | | | | | | | | | | | **n/o** | 95.9 | 9.8 |
| 10/24/07 | n | | | | | | | | | | | | **n/o** | 84.6 | 3.7 |
| 10/25/07 | n | | | | | | | | | | | | **n/o** | 72.2 | 1.8 |
| 10/26/07 | n | | | | | | | | | | | | **n/o** | 74.2 | 6.2 |
| 10/27/07 | n | | | | | | | | | | | | **n/o** | 96.1 | 12.4 |
| 10/28/07 | n | | | | | | | | | | | | **n/o** | 67.6 | -1.1 |
| 10/29/07 | n | | | | | | | | | | | | **n/o** | 77.1 | -0.7 |
| 10/30/07 | n | | | | | | | | | | | | **n/o** | 76.4 | -0.8 |
| 10/31/07 | n | | | | | | | | | | | | **n/o** | 87.2 | 9.0 |
| 11/1/07 | n | | | | | | | | | | | | **n/o** | 72.6 | 4.5 |
| **By Species** | | **0** | 1 | **0** | 3 | 1 | **0** | 1 | 47 | 39 | **0** | 1 | **93** | | |
| **By Guild** | | **4** | | | | **2** | | | **47** | **40** | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | |

n/o - indicates that detector was not operating on that night

**FALL 2007 BAT MIGRATION SURVEY**
Proposed Oakfield Wind Project
July 2008

**Appendix A Table 3**. Summary of acoustic bat data and weather during each survey night at the Sam Drew Tree detector – Fall 2007

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Night of** | **Operated Okay?** | **big brown bat** | **hoary bat** | **silver-haired bat** | **silver-haired/big brown** | **eastern pipistrelle** | **eastern red bat** | **pipistrelle/red bat** | **MYSP** | **high-frequency** | **low-frequency** | **unknown** | **Total** | **Relative Humidity (%)** | **Temperature (celsius)** |
| 8/2/07 | y | | | | 1 | | | | 15 | 13 | | | **29** | | |
| 8/3/07 | y | | | | | | | | 1 | 4 | | | **5** | | |
| 8/4/07 | y | | | | 2 | 1 | | 1 | 9 | 4 | | | **17** | | |
| 8/5/07 | y | | | | 1 | | | | 5 | 13 | | | **19** | | |
| 8/6/07 | y | | | | | | | | | 1 | | | **1** | | |
| 8/7/07 | y | | | | 1 | | | | 6 | 3 | | | **10** | | |
| 8/8/07 | y | | | | | | | | | | | | **0** | | |
| 8/9/07 | y | | | | | | | 1 | 1 | 6 | | | **8** | | |
| 8/10/07 | y | | | | | | | | 3 | 1 | | | **4** | | |
| 8/11/07 | y | | | | | | | | | 5 | | | **5** | | |
| 8/12/07 | y | | | | | | | | 3 | 5 | | | **8** | | |
| 8/13/07 | y | | | | | | | | 1 | 1 | | | **2** | | |
| 8/14/07 | y | | | | | | | 2 | 3 | 3 | | | **8** | | |
| 8/15/07 | y | | | | | | | | | 2 | | | **2** | | |
| 8/16/07 | y | | | | | | | | 1 | | | | **1** | | |
| 8/17/07 | y | | | | | | | | | | | | **0** | | |
| 8/18/07 | y | | | | | | | | | | | | **0** | | |
| 8/19/07 | y | | | | | | | | | | | | **0** | | |
| 8/20/07 | y | | | | | | | | 1 | 1 | | | **2** | 48.8 | 19.3 |
| 8/21/07 | y | | | | 1 | | | | 5 | 10 | | | **16** | 50.0 | 13.0 |
| 8/22/07 | y | | | | | 1 | | | 5 | 3 | | | **9** | 66.9 | 13.8 |
| 8/23/07 | y | | | | | | | | 1 | 1 | | | **2** | 86.7 | 14.7 |
| 8/24/07 | y | | | | | | | | | | | | **0** | 98.6 | 19.7 |
| 8/25/07 | y | | | | | | | | 1 | 1 | | | **2** | 98.3 | 20.1 |
| 8/26/07 | y | | | | | | | | 3 | 4 | | | **7** | 87.9 | 14.5 |
| 8/27/07 | y | | | | | | | | 2 | 3 | 1 | | **6** | 73.6 | 15.0 |
| 8/28/07 | y | | | | | | | | 1 | 1 | | | **2** | 67.0 | 17.1 |
| 8/29/07 | y | | | | | | | | | 3 | | | **3** | 78.0 | 18.1 |
| 8/30/07 | y | | | | | | | | | | | | **0** | 98.2 | 13.8 |
| 8/31/07 | y | | | | | | | | | | | | **0** | 97.1 | 11.2 |
| 9/1/07 | y | | | | | | | | | | | | **0** | 80.0 | 8.8 |
| 9/2/07 | y | | | | | | | | | 1 | | | **1** | 73.4 | 13.5 |
| 9/3/07 | y | | | | | | | | 2 | 3 | 1 | | **6** | 74.9 | 14.2 |
| 9/4/07 | y | | | | | | | | | | | | **0** | 69.9 | 8.0 |
| 9/5/07 | y | | | | | | | | 1 | | | | **1** | 66.5 | 8.9 |
| 9/6/07 | y | | | | | | | | | | | | **0** | 82.8 | 13.8 |
| 9/7/07 | y | | | | | | | | 1 | | 1 | | **2** | 80.2 | 21.8 |
| 9/8/07 | y | | | | | | | | | | | | **0** | 79.3 | 12.7 |
| 9/9/07 | y | | | | | | | | 1 | | | | **1** | 94.0 | 12.1 |
| 9/10/07 | y | | | | | | | | | | | | **0** | 98.1 | 12.8 |
| 9/11/07 | y | | | | | | | | | | | | **0** | 99.0 | 13.4 |
| 9/12/07 | y | | | | | | | | | | | | **0** | 78.5 | 8.7 |
| 9/13/07 | y | | | | | | | | | | 1 | | **1** | 61.6 | 7.6 |
| 9/14/07 | y | | | | | | | | | | | | **0** | 91.4 | 11.7 |
| 9/15/07 | y | | | | | | | | | | 1 | | **1** | 96.4 | 5.3 |
| 9/16/07 | y | | | | | | | | | | | | **0** | 80.0 | 5.3 |
| 9/17/07 | y | | | | | | | | | | | | **0** | 65.6 | 10.5 |
| 9/18/07 | y | | | | | | | | | | | | **0** | 69.1 | 11.8 |
| 9/19/07 | y | | | | 1 | | | | | | | | **1** | 82.0 | 12.2 |
| 9/20/07 | y | | | | | | | | 1 | | | | **1** | 82.2 | 12.2 |
| 9/21/07 | y | | | | | | | | | 1 | | | **1** | 87.4 | 14.7 |
| 9/22/07 | y | | | | | | | | | | | | **0** | 94.4 | 13.5 |
| 9/23/07 | y | | | | | | | | | 1 | | | **1** | 55.8 | 9.3 |
| 9/24/07 | y | | | | | | | | | 1 | | | **1** | 43.1 | 12.0 |
| 9/25/07 | y | | | | | | | | 1 | | | | **1** | 69.4 | 21.8 |
| **By Species** | | **0** | **0** | **0** | 7 | 2 | **0** | 4 | 74 | 95 | 5 | **0** | **187** | | |
| **By Guild** | | **7** | | | | **6** | | | **74** | **100** | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | |

n/o - indicates that detector was not operating on that night

**FALL 2007 BAT MIGRATION SURVEY**
Proposed Oakfield Wind Project
July 2008

**Appendix A Table 4**. Summary of acoustic bat data and weather during each survey night at the Valley Tree detector – Fall 2007

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Night of** | **Operated Okay?** | **big brown bat** | **hoary bat** | **silver-haired bat** | **silver-haired/big brown** | **eastern pipistrelle** | **eastern red bat** | **pipistrelle/red bat** | **MYSP** | **high-frequency** | **low-frequency** | **unknown** | **Total** | **Relative Humidity (%)** | **Temperature (celsius)** |
| 8/2/07 | y | | | | | | | | 8 | 24 | | 6 | **38** | | |
| 8/3/07 | y | | | | | | | | 9 | 10 | | 4 | **23** | | |
| 8/4/07 | y | | | | | | | | | 10 | | 3 | **13** | | |
| 8/5/07 | y | | | | | | | | | 3 | 1 | 2 | **6** | | |
| 8/6/07 | y | | | | | | | | 6 | 11 | | 7 | **24** | | |
| 8/7/07 | y | | | | | | | | 32 | 19 | | 7 | **58** | | |
| 8/8/07 | y | | | | | | | | 1 | 3 | 1 | 1 | **6** | | |
| 8/9/07 | y | | | | | | | | 1 | | | 1 | **2** | | |
| 8/10/07 | y | | | | | | | | 5 | 9 | | | **14** | | |
| 8/11/07 | y | | | | | | | | 5 | 13 | | | **18** | | |
| 8/12/07 | y | | | | | | | | 6 | 7 | | 2 | **15** | | |
| 8/13/07 | y | | | | | | | | 1 | 1 | | 5 | **7** | | |
| 8/14/07 | y | | | | | | | | | 2 | | 3 | **5** | | |
| 8/15/07 | y | | | | | | | | 1 | 1 | | | **2** | | |
| 8/16/07 | y | | | | | | | | 1 | 18 | | 1 | **20** | | |
| 8/17/07 | y | | | | | | | | 1 | 4 | 1 | 1 | **7** | | |
| 8/18/07 | y | | | | | | | | | 2 | | | **2** | | |
| 8/19/07 | y | | | | | | | | | | | | **0** | | |
| 8/20/07 | y | | | | | | | | | 1 | 1 | | **2** | 48.8 | 19.3 |
| 8/21/07 | y | | | | | | | | | 2 | 1 | | **3** | 50.0 | 13.0 |
| 8/22/07 | y | | | | | | | | 6 | 7 | | 1 | **14** | 66.9 | 13.8 |
| 8/23/07 | n | | | | | | | | | | | | **0** | 86.7 | 14.7 |
| 8/24/07 | n | | | | | | | | | | | | **0** | 98.6 | 19.7 |
| 8/25/07 | n | | | | | | | | | | | | **0** | 98.3 | 20.1 |
| 8/26/07 | n | | | | | | | | | | | | **0** | 87.9 | 14.5 |
| 8/27/07 | n | | | | | | | | | | | | **0** | 73.6 | 15.0 |
| 8/28/07 | n | | | | | | | | | | | | **0** | 67.0 | 17.1 |
| 8/29/07 | n | | | | | | | | | | | | **0** | 78.0 | 18.1 |
| 8/30/07 | n | | | | | | | | | | | | **0** | 98.2 | 13.8 |
| 8/31/07 | n | | | | | | | | | | | | **0** | 97.1 | 11.2 |
| 9/1/07 | n | | | | | | | | | | | | **0** | 80.0 | 8.8 |
| 9/2/07 | n | | | | | | | | | | | | **0** | 73.4 | 13.5 |
| 9/3/07 | n | | | | | | | | | | | | **0** | 74.9 | 14.2 |
| 9/4/07 | y | | | | | | | | 1 | | | | **1** | 69.9 | 8.0 |
| 9/5/07 | y | | | | | | | | | 1 | | | **1** | 66.5 | 8.9 |
| 9/6/07 | y | | | | | | | | 7 | 3 | 2 | | **12** | 82.8 | 13.8 |
| 9/7/07 | y | | | | | | | | 26 | 12 | 1 | | **39** | 80.2 | 21.8 |
| 9/8/07 | y | | | | | | | | 20 | 11 | 1 | | **32** | 79.3 | 12.7 |
| 9/9/07 | y | | | | | | | | 5 | | 1 | | **6** | 94.0 | 12.1 |
| 9/10/07 | y | | | | | | | | 3 | 3 | | | **6** | 98.1 | 12.8 |
| 9/11/07 | y | | | | | | | | 1 | | 1 | | **2** | 99.0 | 13.4 |
| 9/12/07 | y | | | | | | | | 2 | 1 | 3 | | **6** | 78.5 | 8.7 |
| 9/13/07 | y | | | | | | | | 1 | | | | **1** | 61.6 | 7.6 |
| 9/14/07 | y | | | | | | | | 11 | 1 | | | **12** | 91.4 | 11.7 |
| 9/15/07 | y | | | | | | | | 4 | 2 | | | **6** | 96.4 | 5.3 |
| 9/16/07 | y | | | | | | | | | | | | **0** | 80.0 | 5.3 |
| 9/17/07 | y | | | | | | | | | 1 | | | **1** | 65.6 | 10.5 |
| 9/18/07 | y | | | | | | | | 3 | 1 | 1 | | **5** | 69.1 | 11.8 |
| 9/19/07 | y | | | | | | | | 37 | 3 | 2 | | **42** | 82.0 | 12.2 |
| 9/20/07 | y | | | | | | | | 4 | | | | **4** | 82.2 | 12.2 |
| 9/21/07 | y | | | | | | | | 1 | | | | **1** | 87.4 | 14.7 |
| 9/22/07 | y | | | | | | | | | | | | **0** | 94.4 | 13.5 |
| 9/23/07 | y | | | | | | | | | | | | **0** | 55.8 | 9.3 |
| 9/24/07 | y | | | | | | | | | | | | **0** | 43.1 | 12.0 |
| 9/25/07 | y | | | | | | | | | | | | **0** | 69.4 | 21.8 |
| **By Species** | | **0** | **0** | **0** | **0** | **0** | **0** | **0** | 209 | 186 | 17 | 44 | **456** | | |
| **By Guild** | | **0** | | | | **0** | | | **209** | **247** | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | |

n/o - indicates that detector was not operating on that night

**FALL 2007 BAT MIGRATION SURVEY**
Proposed Oakfield Wind Project
July 2008

**Appendix A Table 5**. Summary of acoustic bat data and weather during each survey night at the Met High detector – Fall 2007

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Night of** | **Operated Okay?** | **big brown bat** | **hoary bat** | **silver-haired bat** | **silver-haired/big brown** | **eastern pipistrelle** | **eastern red bat** | **pipistrelle/red bat** | **MYSP** | **high-frequency** | **low-frequency** | **unknown** | **Total** | **Relative Humidity (%)** | **Temperature (celsius)** |
| 9/26/07 | y | | | | | | | | | | | | **0** | 82.2 | 15.5 |
| 9/27/07 | y | | | | | | | | | | | | **0** | 97.2 | 15.9 |
| 9/28/07 | y | | | | | | | | | | | | **0** | 97.3 | 7.1 |
| 9/29/07 | y | | | | | | | | | | | | **0** | 75.5 | 3.7 |
| 9/30/07 | y | | | | | | | | | | | | **0** | 67.3 | 8.0 |
| 10/1/07 | y | | | | | | | | | | | | **0** | 93.6 | 9.6 |
| 10/2/07 | y | | | | | | | | | | | | **0** | 87.9 | 11.7 |
| 10/3/07 | y | | | | | | | | | | | | **0** | 93.6 | 15.7 |
| 10/4/07 | y | | | | | | | | | | | | **0** | 57.7 | 13.2 |
| 10/5/07 | y | | | | | | | | | | | | **0** | 62.2 | 14.6 |
| 10/6/07 | y | | | | | | | | | | | | **0** | 61.9 | 7.0 |
| 10/7/07 | y | | | | | | | | | | | | **0** | 71.0 | 3.5 |
| 10/8/07 | y | | | | | | | | | | | | **0** | 90.7 | 5.2 |
| 10/9/07 | y | | | | | | | | | | | | **0** | 88.6 | 7.0 |
| 10/10/07 | y | | | | | | | | | | | | **0** | 97.9 | 8.5 |
| 10/11/07 | y | | | | | | | | | | | | **0** | 98.5 | 8.4 |
| 10/12/07 | y | | | | | | | | | | | | **0** | 99.1 | 8.6 |
| 10/13/07 | y | | | | | | | | | | | | **0** | 88.3 | 3.6 |
| 10/14/07 | y | | | | | | | | | | | | **0** | 97.2 | 1.3 |
| 10/15/07 | y | | | | | | | | | | | | **0** | 86.8 | 2.9 |
| 10/16/07 | y | | | | | | | | | | | | **0** | 80.4 | 3.6 |
| 10/17/07 | y | | | | | | | | | | | | **0** | 75.3 | 5.7 |
| 10/18/07 | y | | | | | | | | | | | | **0** | 61.1 | 11.1 |
| 10/19/07 | y | | | | | | | | | | | | **0** | 98.4 | 14.9 |
| 10/20/07 | y | | | | | | | | | | | | **0** | 78.3 | 11.5 |
| 10/21/07 | y | | | | | | | | | | | | **0** | 57.2 | 14.9 |
| 10/22/07 | y | | | | | | | | | | | | **0** | 52.2 | 17.4 |
| 10/23/07 | y | | | | | | | | | | | | **0** | 95.9 | 9.8 |
| 10/24/07 | y | | | | | | | | | | | | **0** | 84.6 | 3.7 |
| 10/25/07 | y | | | | | | | | | | | | **0** | 72.2 | 1.8 |
| 10/26/07 | y | | | | | | | | | | | | **0** | 74.2 | 6.2 |
| 10/27/07 | y | | | | | | | | | | | | **0** | 96.1 | 12.4 |
| 10/28/07 | y | | | | | | | | | | | | **0** | 67.6 | -1.1 |
| 10/29/07 | y | | | | | | | | | | | | **0** | 77.1 | -0.7 |
| 10/30/07 | y | | | | | | | | | | | | **0** | 76.4 | -0.8 |
| 10/31/07 | y | | | | | | | | | | | | **0** | 87.2 | 9.0 |
| 11/1/07 | y | | | | | | | | | | | | **0** | 72.6 | 4.5 |
| **By Species** | | **0** | **0** | **0** | 0 | 0 | **0** | 0 | 0 | 0 | 0 | **0** | **0** | | |
| **By Guild** | | **0** | | | | **0** | | | **0** | **0** | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | |

n/o - indicates that detector was not operating on that night

**FALL 2007 BAT MIGRATION SURVEY**
Proposed Oakfield Wind Project
July 2008

**Appendix A Table 6**. Summary of acoustic bat data and weather during each survey night at the Met Low detector – Fall 2007

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Night of | Operated Okay? | big brown bat | hoary bat | silver-haired bat | silver-haired/big brown | eastern pipistrelle | eastern red bat | pipistrelle/red bat | MYSP | high-frequency | low-frequency | unknown | Total | Relative Humidity (%) | Temperature (celsius) |
| 9/26/07 | n | | | | | | | | | | | | **n/o** | 82.2 | 15.5 |
| 9/27/07 | n | | | | | | | | | | | | **n/o** | 97.2 | 15.9 |
| 9/28/07 | n | | | | | | | | | | | | **n/o** | 97.3 | 7.1 |
| 9/29/07 | n | | | | | | | | | | | | **n/o** | 75.5 | 3.7 |
| 9/30/07 | n | | | | | | | | | | | | **n/o** | 67.3 | 8.0 |
| 10/1/07 | n | | | | | | | | | | | | **n/o** | 93.6 | 9.6 |
| 10/2/07 | n | | | | | | | | | | | | **n/o** | 87.9 | 11.7 |
| 10/3/07 | n | | | | | | | | | | | | **n/o** | 93.6 | 15.7 |
| 10/4/07 | n | | | | | | | | | | | | **n/o** | 57.7 | 13.2 |
| 10/5/07 | n | | | | | | | | | | | | **n/o** | 62.2 | 14.6 |
| 10/6/07 | n | | | | | | | | | | | | **n/o** | 61.9 | 7.0 |
| 10/7/07 | n | | | | | | | | | | | | **n/o** | 71.0 | 3.5 |
| 10/8/07 | n | | | | | | | | | | | | **n/o** | 90.7 | 5.2 |
| 10/9/07 | n | | | | | | | | | | | | **n/o** | 88.6 | 7.0 |
| 10/10/07 | n | | | | | | | | | | | | **n/o** | 97.9 | 8.5 |
| 10/11/07 | n | | | | | | | | | | | | **n/o** | 98.5 | 8.4 |
| 10/12/07 | n | | | | | | | | | | | | **n/o** | 99.1 | 8.6 |
| 10/13/07 | n | | | | | | | | | | | | **n/o** | 88.3 | 3.6 |
| 10/14/07 | n | | | | | | | | | | | | **n/o** | 97.2 | 1.3 |
| 10/15/07 | n | | | | | | | | | | | | **n/o** | 86.8 | 2.9 |
| 10/16/07 | n | | | | | | | | | | | | **n/o** | 80.4 | 3.6 |
| 10/17/07 | n | | | | | | | | | | | | **n/o** | 75.3 | 5.7 |
| 10/18/07 | n | | | | | | | | | | | | **n/o** | 61.1 | 11.1 |
| 10/19/07 | n | | | | | | | | | | | | **n/o** | 98.4 | 14.9 |
| 10/20/07 | n | | | | | | | | | | | | **n/o** | 78.3 | 11.5 |
| 10/21/07 | n | | | | | | | | | | | | **n/o** | 57.2 | 14.9 |
| 10/22/07 | n | | | | | | | | | | | | **n/o** | 52.2 | 17.4 |
| 10/23/07 | n | | | | | | | | | | | | **n/o** | 95.9 | 9.8 |
| 10/24/07 | n | | | | | | | | | | | | **n/o** | 84.6 | 3.7 |
| 10/25/07 | n | | | | | | | | | | | | **n/o** | 72.2 | 1.8 |
| 10/26/07 | n | | | | | | | | | | | | **n/o** | 74.2 | 6.2 |
| 10/27/07 | n | | | | | | | | | | | | **n/o** | 96.1 | 12.4 |
| 10/28/07 | n | | | | | | | | | | | | **n/o** | 67.6 | -1.1 |
| 10/29/07 | n | | | | | | | | | | | | **n/o** | 77.1 | -0.7 |
| 10/30/07 | n | | | | | | | | | | | | **n/o** | 76.4 | -0.8 |
| 10/31/07 | n | | | | | | | | | | | | **n/o** | 87.2 | 9.0 |
| 11/1/07 | n | | | | | | | | | | | | **n/o** | 72.6 | 4.5 |
| **By Species** | | **0** | **0** | **0** | **0** | **0** | **0** | **0** | 0 | 0 | 0 | 0 | **0** | | |
| **By Guild** | | **0** | | | | **0** | | | **0** | **0** | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | |

n/o - indicates that detector was not operating on that night

**FALL 2007 BAT MIGRATION SURVEY**
Proposed Oakfield Wind Project
July 2008

# Appendix 7-5
# Spring and Summer 2008 Bird and Bat Migration Survey Report for the Oakfield Wind Project, Oakfield, Maine

# Spring and Summer 2008 Bird and Bat Migration Survey Report

## Visual, Radar, and Acoustic Bat Surveys for the Oakfield Wind Project in Oakfield, Maine

Prepared for

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Prepared by

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**January 2009**

# Executive Summary

During spring and summer 2008, Stantec Consulting (Stantec) conducted field surveys of bird and bat migration activity at the Oakfield wind project area in Oakfield, Maine. The surveys are part of the planning process by First Wind Energy, LLC (First Wind) for a proposed wind project (Project). These surveys represented the second season of investigations undertaken at this site. The results of the field surveys provide useful information about site-specific migration activity and patterns in the vicinity of the Project area, including species composition and timing.

*Nocturnal Radar Survey*

The spring 2008 field survey targeted 20 nights of nocturnal radar sampling between April 15 and June 7. Surveys were delayed, however, until May 1 due to the presence of significant snow-pack and subsequent area flooding. Surveys were conducted using X-band radar, sampling from sunset to sunrise. Each hour of sampling included the recording of radar video files during horizontal and vertical operation. The radar location at the summit of Sam Drew Mountain, the highest point within the Project area, allowed for unobstructed views nearly 360 degrees around the radar. The topography and tree height at this location also allowed for some limited views to the east/southeast below the height of the radar in the valley below.

The overall passage rate for the entire survey period was 498 targets per kilometer per hour (t/km/hr) with single nightly passage rates varying from 132 t/km/hr to 899 t/km/hr. Mean flight direction through the Project area was 33º ± 65º.

The mean flight height of targets was 276 meters (m) (905 feet [’]) above the radar site. The average nightly flight height ranged from 111 m (364’) to 519 m (1703’). The percent of targets observed flying below 120 m (394’), the maximum projected height of the proposed turbines, was 21 percent.

The mean flight direction, qualitative analysis of the surrounding topography and landscape, and mean flight altitude of targets passing over the Project area together indicate that avian migration in this area involves a broad front type of landscape movement, rather than a concentration or funneling of flight movements over or through any particular part of the Project area. This type of broad front movement, particularly in conjunction with the high flight heights, demonstrates a limited avian mortality risk during spring migration. Additionally, the flight height of targets indicates that the vast majority of bird migration in the area occurs well above the height of the proposed wind turbines.

*Bat Survey*

The spring and summer field surveys included documentation of bat activity through passive surveys with six acoustic detectors, resulting in 565 detector-nights of recordings from April 25 to August 11. Two detectors were deployed in a meteorological measurement tower for the

entire survey period, two detectors were deployed in trees for the entire survey period, and two detectors were placed in trees for part of the survey period and subsequently moved to a met tower. During the spring survey, a total of 600 bat call sequences were recorded, with a mean detection rate for all detectors of 3.8 detections per detector-night. The mean rate for tree detectors was higher (6.8 detections per detector-night) than the mean rate for the met tower detectors (0.2 detections per detector-night). During the summer survey, a total of 6,103 call sequences were recorded, with a mean detection rate for all detectors of 15.0 detections per detector-night. The mean rate for tree detectors was higher (30.5 detections per detector-night) than for the met tower detectors (1.1 detections per detector-night).

Bat calls were identified to the lowest possible taxonomic level. These were then grouped into four guilds based on similarity in call characteristics between some species and the uncertainty in the ability of frequency division detectors to adequately provide information for this differentiation. In both seasons, the majority of calls (62% in the spring, 68% in the summer) were identified as *Myotis*. Approximately one-third of all calls could not be identified (38% in the spring 32% in the summer) and less than one percent of calls were identified as species in the red bat/eastern pipistrelle guild or big brown guild. This trend in species composition is similar to that of other studies in the region.

*Diurnal Raptor Survey*

In addition to the nocturnal radar and passive bat surveys, a total of 12 days of diurnal raptor surveys (79 hours of observation) were conducted from an observation point at the summit of Sam Drew Mountain. Surveys were conducted generally between 9:00 am and 4:00 pm on days with weather conditions favorable for migration. A total of seven species, involving 58 individual birds, were seen, with an overall passage rate of 0.7 raptors per observation-hour. The flight heights of raptors in the Project area indicate that 76 percent of the observations occurred below 120 m above the ground; however, only 32 percent were observed directly over the project ridgeline. Differences between species were observed and are likely due to typical flight height preferences, species behavior, or to limitations in the distance that different species are visible. Despite this, the greater occurrence of migrants at low altitudes increases the potential for migrating raptors to encounter proposed wind turbines; however, diurnal activity patterns and raptor avoidance patterns make these encounters less likely despite the reported low flight heights.

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PN195600152

# 1.0 Introduction

This report has been prepared to document and discuss observed avian and bat activity patterns and species composition within the proposed Oakfield wind project area (Figure 1-1).

In advance of permitting activities for this Project, First Wind contracted Stantec Consulting, (Stantec) formerly Woodlot Alternatives, Inc.[1], to conduct avian and bat surveys to determine the presence and, when possible, species composition of birds and bats in the Project area. The scope of these surveys was based on a combination of standard methods that are developing within the wind power industry for pre-construction surveys and is consistent with a number of other studies conducted recently in Maine and throughout the Northeast region of the United States.

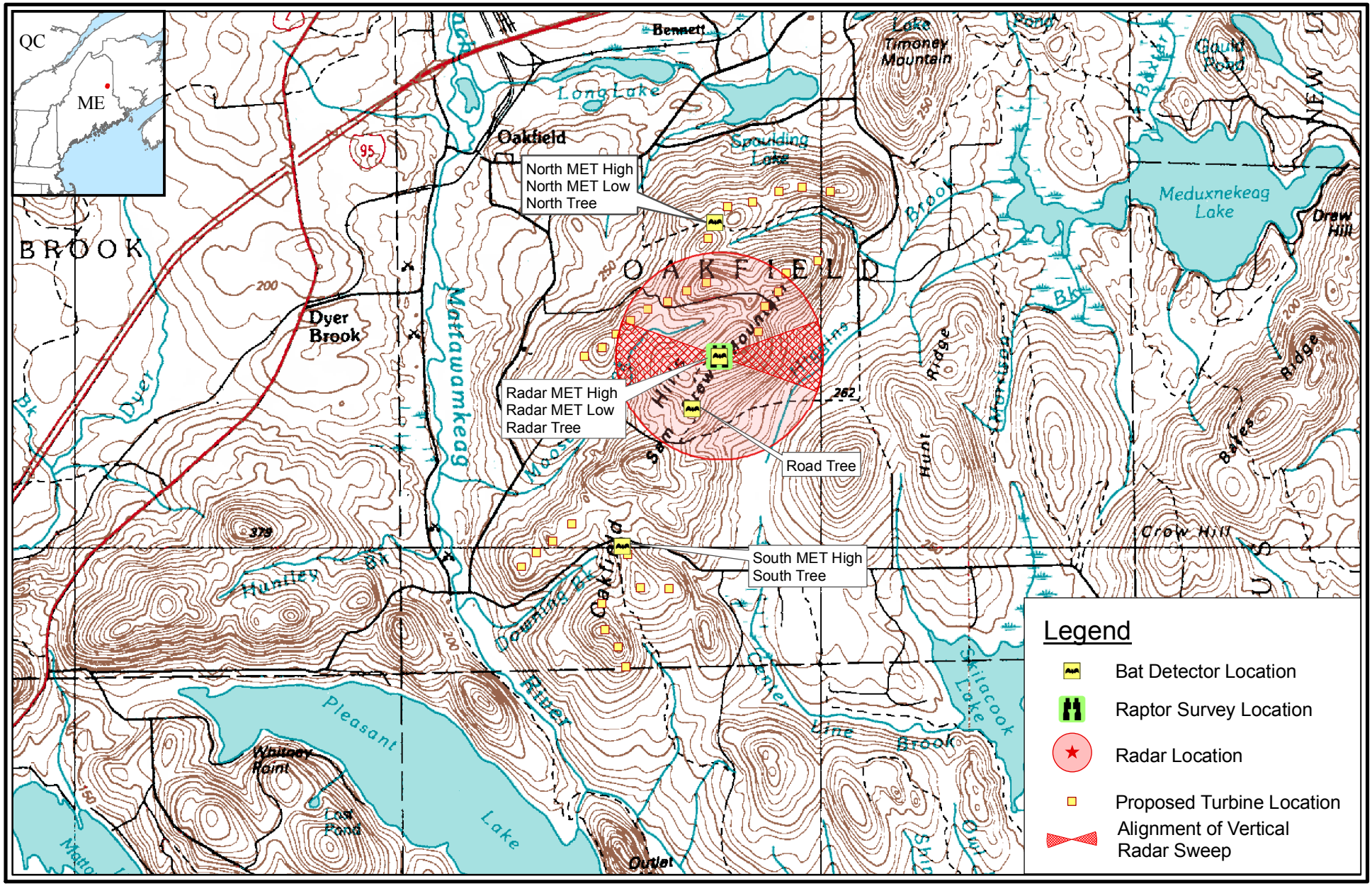
## 1.1 SURVEY OVERVIEW

Stantec conducted field investigations, or surveys, for bird and bat migration during spring and summer 2008. The overall goals of the investigations were to document:

- passage rates for nocturnal migration in the vicinity of the Project area during spring, including the number of migrants, their flight direction, and their flight altitude;
- activity patterns of bats in the Project area during spring and summer, including the rate of occurrence and relationship with weather factors;
- and passage rates and species composition of raptors during spring migration through the Project area.

The following sections outline the survey methodology and results contributing toward the achievement of survey goals. Discussion of survey results and subsequent conclusions follow each section.

[1] On October 1, 2007, Woodlot Alternatives, Inc. was formally acquired by Stantec Consulting Services, Inc.




Prepared By:

Stantec

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Sheet Title:

*Project and Survey Location Map Spring & Summer 2008*

Project:

*Oakfield Wind Project*
*Oakfield, Maine*

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| Scale: | 1" = 6000' |
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# 2.0 Nocturnal Radar Survey

## 2.1 INTRODUCTION

The majority of North American passerines migrate at night. The strategy to migrate at night may have evolved to take advantage of more stable atmospheric conditions for flapping flight (Kerlinger 1995). Additionally, night migration may provide a more efficient medium to regulate body temperature during active, flapping flight and could reduce the potential for predation while in flight (Alerstam 1990, Kerlinger 1995). Conversely, species, such as raptors, that use soaring flight migrate during the day to take advantage of warm rising air in thermals and laminar flow of air over the landscape, which can create updrafts along hillsides and ridgelines. Whereas raptor migration can be documented by visual daytime surveys, documenting the patterns of nocturnally migrating birds requires the use of radar or other non-visual technologies. Nocturnal radar surveys were conducted in the Project area to characterize spring nocturnal migration patterns. The goal of the surveys was to document the overall passage rates for nocturnal migration in the vicinity of the Project area, including the number of migrants, their flight direction, and their flight altitude relative to the ground elevation at the radar site on the ridgeline.

## 2.2 METHODS

The radar study was conducted from the summit of Sam Drew Mountain (Figure 1-1).

Marine surveillance radar, similar to that described by Cooper *et al.* (1991), was used during field data collection. The radar has a peak power output of 12 kilowatts (kW) and has the ability to track small animals, including birds, bats, and even insects, based on settings selected for the radar functions. It cannot, however, readily distinguish between different types of animals being detected. Consequently, all animals observed on the radar screen were identified as “targets.” The radar has an “echo trail” function which captures past echoes of flight trails, enabling determination of flight direction. During all operations, the radar’s echo trail was set to 30 seconds. The radar was equipped with a 2 m (6.5’) waveguide antenna. The antenna has a vertical beam height of 20º (10º above and below horizontal), and the front end of the antenna was inclined approximately 5º to increase the proportion of the beam directed into the sky. Objects on the ground detected by the radar cause returns on the radar screen (echoes) that appear as blotches called ground clutter. Large amounts of ground clutter reduce the ability of the radar to track birds and bats flying over those areas. However, vegetation and hilltops near the radar can be used to reduce or eliminate ground clutter by “hiding” clutter-causing objects from the radar. These nearby features also cause ground clutter, but their proximity to the radar antenna generally limits the ground clutter to the center of the radar screen (Figure 2-1). The presence or reduction of potential clutter producing objects was carefully considered during site selection and radar station configuration.

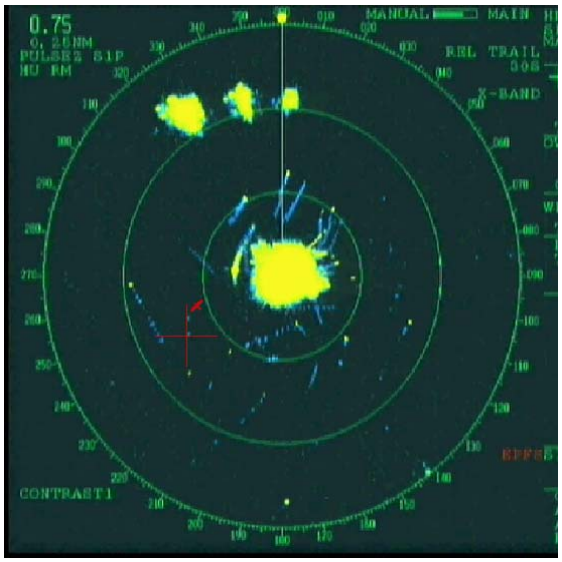


**Figure 2-1.** Ground clutter in Project area

Radar surveys were typically conducted from sunset to sunrise. Twenty nights of surveys were targeted between April 15 and June 7. Because the anti-rain function of the radar must be turned down to detect small songbirds and bats, surveys could not be conducted during periods of inclement weather. Therefore, surveys were planned largely for nights without rain. However, in order to characterize migration patterns during nights without optimal conditions, some nights with weather forecasts including occasional showers were sampled.

The radar was operated in two modes throughout the night. In surveillance mode, the antenna spins horizontally to survey the airspace around the radar and detects targets moving through the area. By analyzing the echo trail, the flight direction of targets can be determined. In vertical mode, the radar unit is tilted 90º to vertically survey the airspace above the radar (Harmata *et al.* 1999). In vertical mode, target echoes do not provide directional data, but do provide information on the altitude of targets passing through the vertical, 20º radar beam. Both modes of operation were used during each hour of sampling.

The radar was operated at a range of 1.4 km (0.75 nautical miles). At this range, the echoes of small birds can be easily detected, observed, and tracked. At greater ranges, larger birds can be detected, but the echoes of small birds are reduced in size and restricted to a smaller portion of the radar screen, thus limiting the ability to observe the movement pattern of individual targets.

### 2.2.1 Data Collection

The radar display was connected to the video recording software of a computer enabling digital archiving of the radar data for subsequent analysis. This software recorded and archived video samples continuously every hour from sunset to sunrise of each survey night. Alternating the radar antenna every ten minutes from vertical mode to horizontal mode, a total of 30 minutes of

vertical samples and 30 minutes of horizontal samples were collected within each hour. Video recordings were subsequently analyzed based on a random schedule for each night.

During each hour, additional information was also recorded, including weather conditions and ceilometer and/or night-vision goggle observations. Ceilometer observations involved directing a one-million candlepower spotlight vertically into the sky in a manner similar to that described by Gauthreaux (1969). The ceilometer beam was observed by eye for 5 minutes to document and characterize low-flying targets. The ceilometer was held in-hand so that any birds, bats, or insects passing through it could be tracked for several seconds, if needed; surveys were conducted from the radar survey site. Observations from each ceilometer observation period were recorded, including the number of birds, bats, and insects observed. This information was used during data analysis to help characterize activity of insects, birds, and bats.

### 2.2.2 Data Analysis

Video samples were analyzed using a digital analysis software tool developed by Woodlot Alternatives, Inc.[2] For horizontal samples, targets (either birds or bats) were differentiated from insects based on their flight speed. Following adjustment for wind speed and direction, targets traveling faster than approximately 6 m (20') per second were identified as a bird or bat target (Larkin 1991, Bruderer and Boldt 2001). The software tool recorded the time, location, and flight vector for each target traveling fast enough to be a bird or bat within each horizontal sample, and these results were output to a spreadsheet. For vertical samples, the software tool recorded the entry point of targets passing through the vertical radar beam, the time, and flight altitude above the radar location, and then subsequently outputs the data to a spreadsheet. These datasets were then used to calculate passage rate (reported as targets per kilometer of migratory front per hour), flight direction, and flight altitude of targets.

Mean target flight directions (± 1 circular standard deviation) were summarized using software designed specifically to analyze directional data (Oriana2© Kovach Computing Services). The statistics used for this analysis are based on those used by Batschelet (1965), because they take into account the circular nature of the data. Nightly wind direction was also summarized using similar methods and data, which was collected from the nearest meteorological measurement tower (met tower) to the radar.

Flight altitude data were summarized using linear statistics. Mean flight altitudes (± 1 standard error [SE]) were calculated by hour, night, and overall season. The percent of targets flying below 120 meters, the approximate maximum height of the proposed wind turbines with blades, was also calculated hourly, for each night, and for the entire survey period.

[2]All field work and any reporting and permitting activities performed prior to October 1, 2007, were conducted as Woodlot Alternatives, Inc. and will be herein referenced as work done by Woodlot. On October 1, 2007, Woodlot Alternatives, Inc. was acquired by Stantec Consulting Services, Inc. Work conducted on or after October 1, 2007 is herein referenced as work done by Stantec.

### 2.2.3 Weather Data

Weather data was collected from an anemometer on the met tower at the summit of Sam Drew Mountain between April 25 and June 7. Additional data was also collected from an on site weather station deployed at the radar location during this same timeframe. For reporting purposes, wind direction and wind speed was recorded by the anemometer. Temperature was recorded by data loggers (HOBO Pro v2 U23-001, Onset Computer Corporation). The mean wind direction, wind speed, and temperature were calculated for each night.

### 2.2.4 NEXRAD Radar Data Analysis

NEXRAD weather radar images from the National Weather Service station in Houlton, Maine (selected for its proximity to the Project area and ability to provide adequate radar coverage) were examined on the dates surrounding the typical spring migration period (April 15 to June 15). These radar images were then used to confirm that the nights selected for the on-site radar sampling period were representative of seasonal migration activity throughout the region. NEXRAD radar provides a different type of data than the marine surveillance radar used on-site. This long-range Doppler radar produces reflectivity data on objects (and precipitation) in the sky, as well as the velocity of those objects. Because it covers such a large area, it does not track individual birds, but can be used to interpret large-scale bird migration patterns and the level of migration activity (Gauthreaux and Belser 1998).

Nightly samples of reflectivity and velocity images were obtained from the National Oceanic and Atmosphere Administration (NOAA 2007) and visually assessed to determine the overall intensity of nightly migration. Each night was qualitatively categorized as: 1) no biological activity (very low activity or rainy nights); 2) light biological activity; or 3) moderate to heavy biological activity (Figure 2-2). These determinations were made based on the color-coded strength of the radar reflectance data, velocity and direction, and winds aloft data. The images selected for this assessment were generally timed to be from two to four hours after sunset. For data interpretation purposes, bird migration is discernable from most precipitation. Bird activity was detected on some nights when rain occurred periodically. On those nights, radar reflectivity patterns indicative of migrating birds were observed forming and then dissolving during those periods between rain events. Nights exhibiting these conditions were classified as having light migration activity.

Once NEXRAD images were analyzed, nights of on-site surveys in the Project area were compared with those same nights of NEXRAD data to confirm on-site sampling occurred during periods of moderate to heavy migration. The remainder of the nightly NEXRAD data was then summarized to identify the proportion of nights with moderate to heavy migration activity within the entire season as compared to nights sampled with on-site radar.

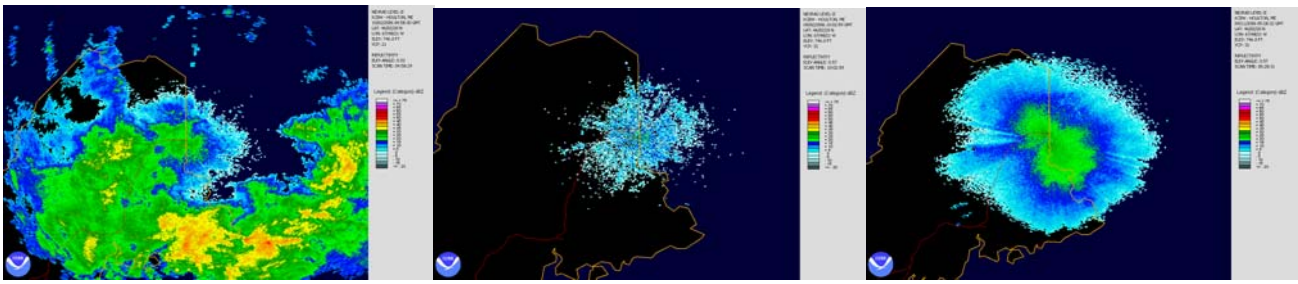

**Figure 2-2.** Examples of NEXRAD radar images depicting (from left to right) rain, light migration, and moderate to heavy migration activity.

## 2.3 RESULTS

Radar surveys were conducted during 20 nights from May 1 to June 3, 2008 (Appendix A, Table 1). The beginning of the survey was delayed by the presence of a significant snowpack and subsequent flooding. Radar surveys were conducted from a 7m (23') tower next to the met tower at the summit of Sam Drew Mountain, the highest point within the Project area (Figure 1-1). At this location, the radar tower afforded unobstructed 360 degree views, although some small areas to the northwest were slightly obstructed due to "groundclutter" caused from the detection of the tree tops on the nearby ridgeline. As a result, the radar was able to detect targets moving over the northwestern quadrant flying at radar level or higher over the northwestern valley. The steep topography to the east and lower tree height on that side of the met tower opening also allowed for the detection of targets flying below the height of the radar over the eastern valley.

### 2.3.1 Passage Rates

The overall passage rate for the entire survey period was 498 targets per kilometer per hour (t/km/hr); individual nightly passage rates varied from 132 t/km/hr on May 1 to 899 t/km/h on May 26 (Figure 2-3; also Appendix A, Table 1). Individual hourly passage rates ranged from 0 to 1496 t/km/hr during the survey period (Appendix A, Table 1). Hourly passage rates were typically highest four to five hours after sunset. For the entire season, passage rates peaked two hours after sunset and decreased consistently until sunrise (Figure 2-4).

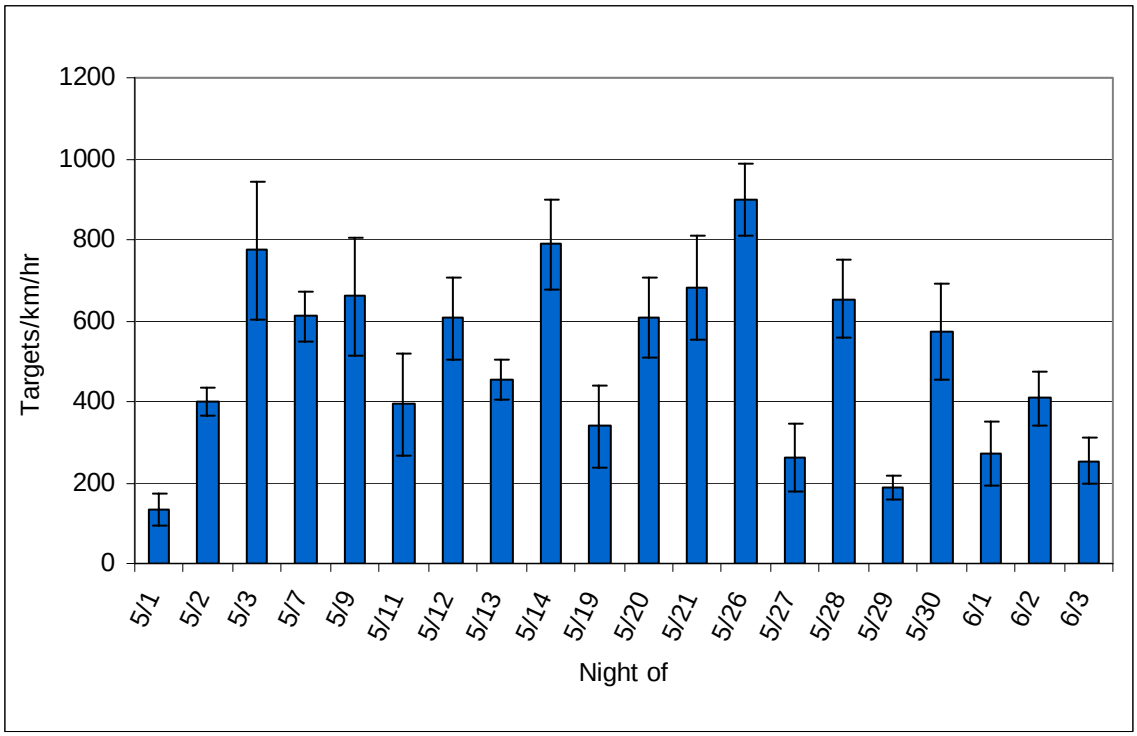


**Figure 2-3.** Nightly passage rates observed (error bars ± 1 SE)

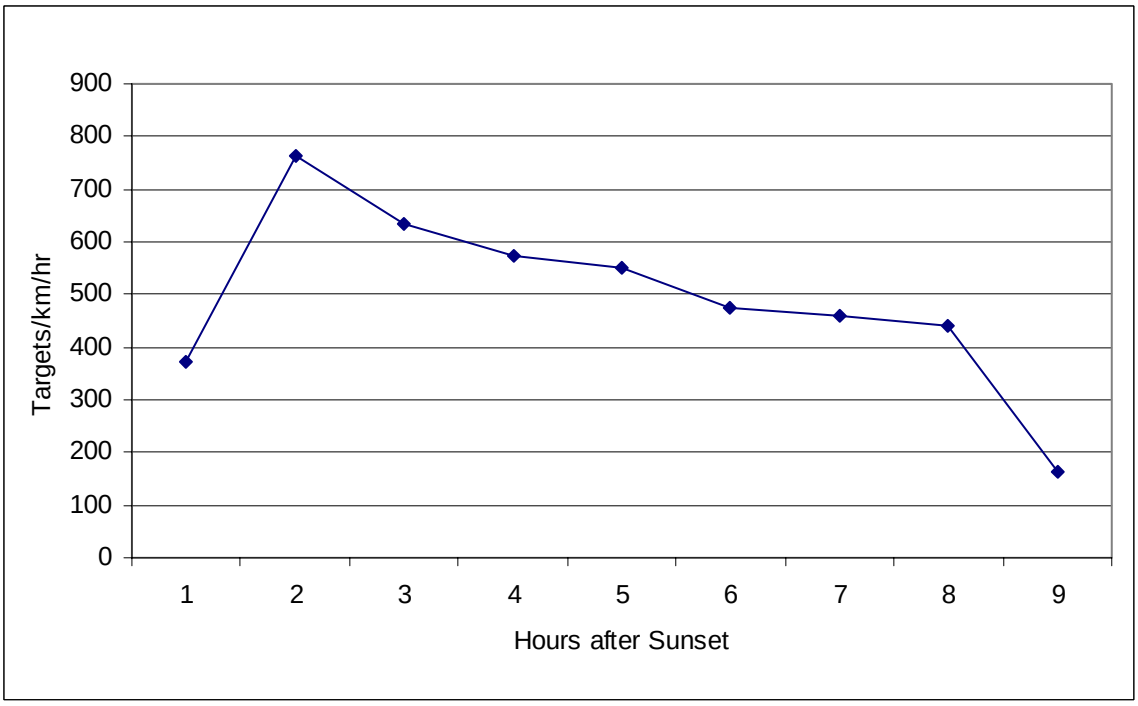


**Figure 2-4.** Hourly passage rates for entire season

### 2.3.2 Flight Direction

Mean flight direction through the Project area was 33° ± 65° (Figure 2-5). Although there was significant variation, most nights included movement generally to the north or northeast, as expected during spring migration periods (Appendix A, Table 2).

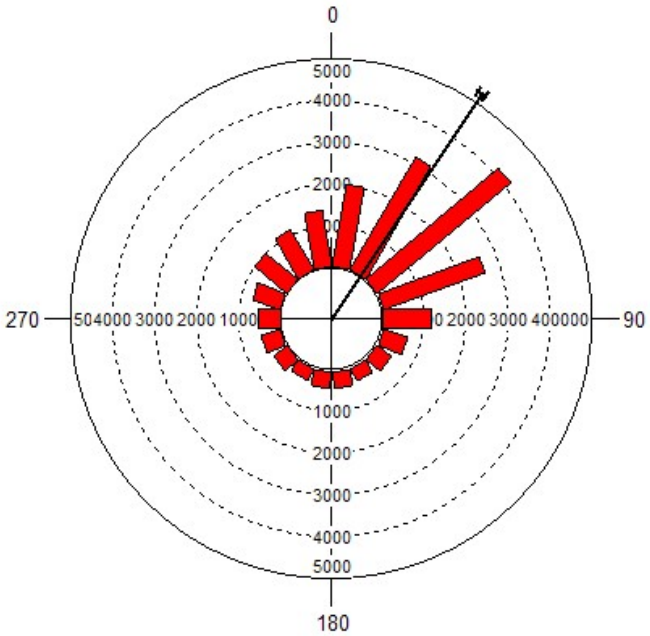


**Figure 2-5.** Mean flight direction for the entire season (the bracket along the margin of the histogram is the 95% confidence interval).

### 2.3.3 Flight Altitude

The seasonal average mean flight height of all targets was 276 m (905‘) above the radar site. The average nightly flight height ranged from 111 m (1703’) on May 19 to 519 (364’) on May 2 (Figure 2-6; Appendix A, Table 3). The percent of targets observed flying below 120 m (394’), the maximum turbine height, was 21%. Flight heights were relatively consistent throughout the night, with a decrease in flight height prior to sunrise (Figure 2-7; Figure 2-8).

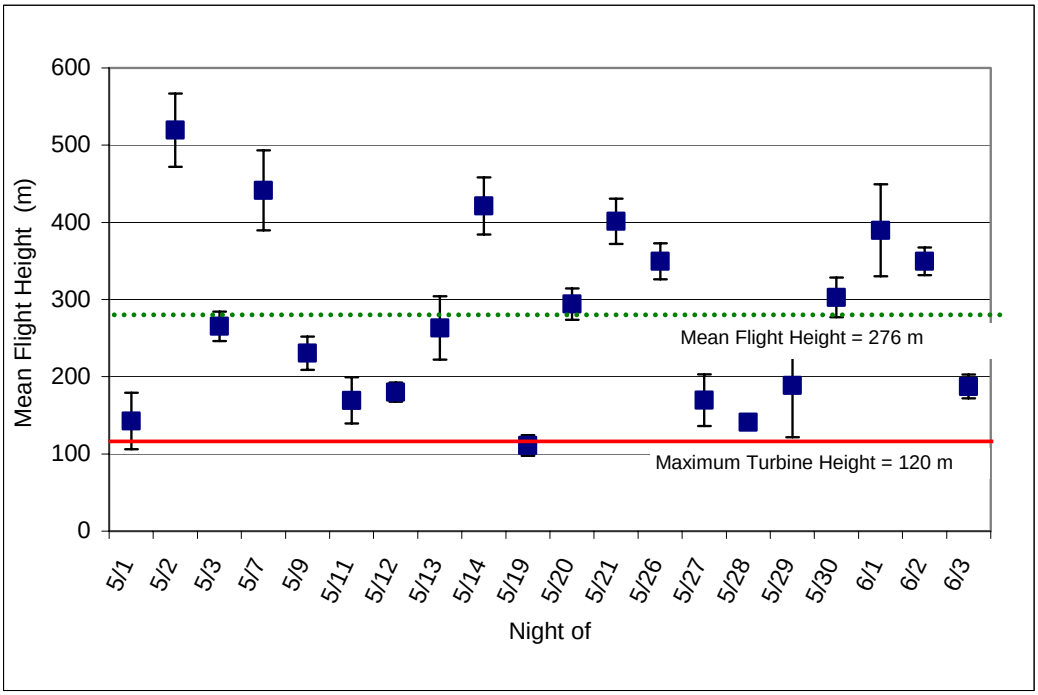


**Figure 2-6.** Mean nightly flight height of targets (error bars ± 1 SE)

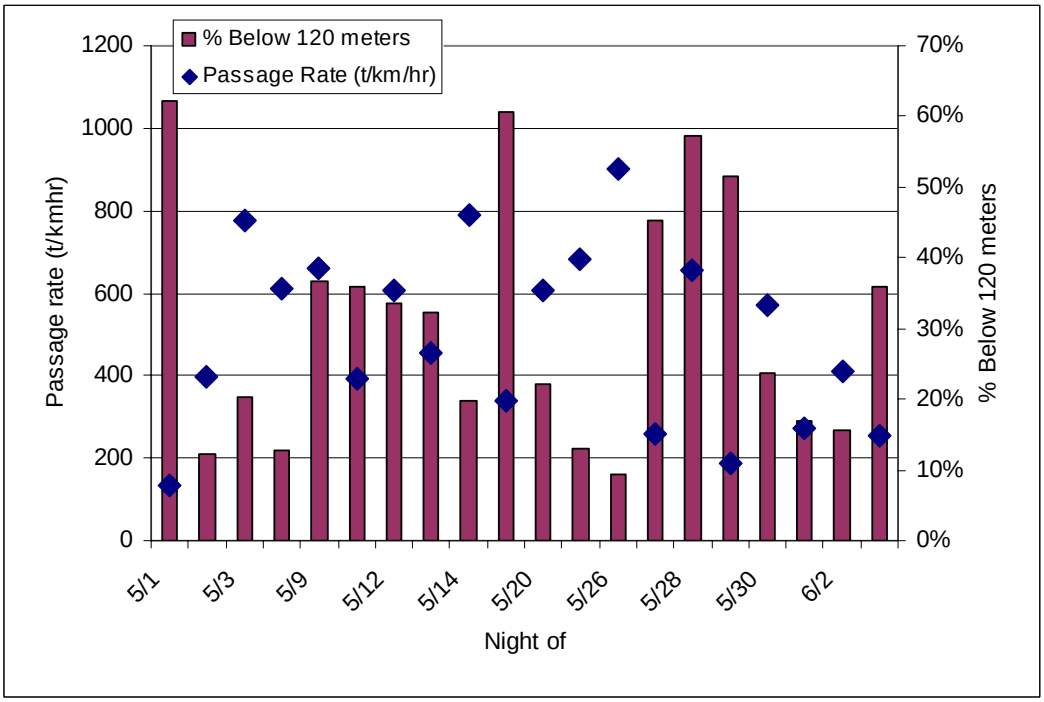


**Figure 2-7.** Percent of targets observed flying below a height of 120 m (394')

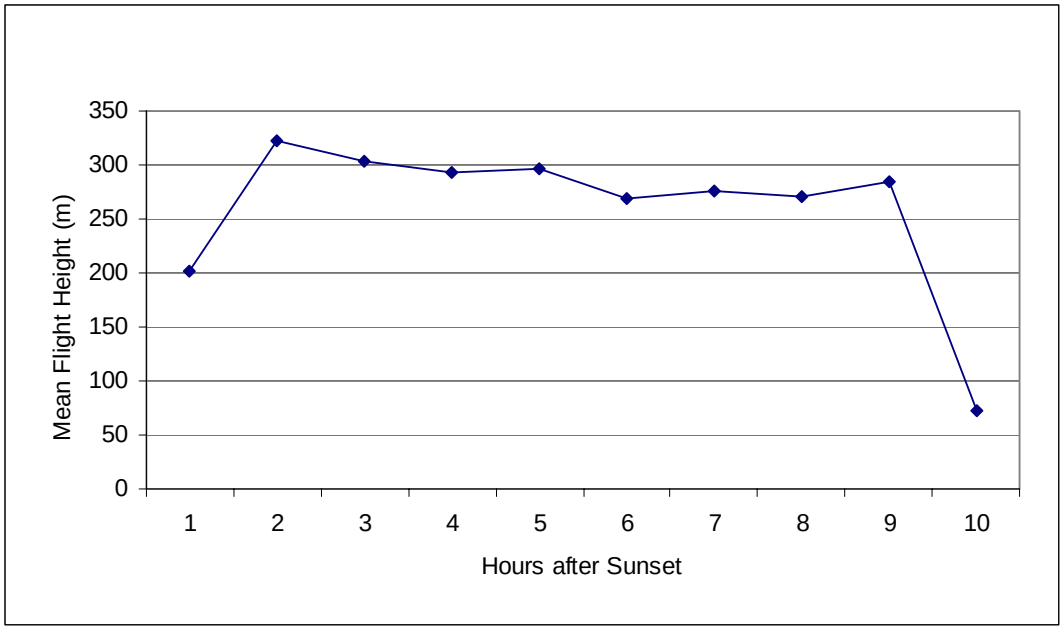


**Figure 2-8.** Hourly target flight height distribution

### 2.3.4 Night-vision Goggle Observations

Night-vision goggle data collected during the radar survey yielded a total of 54 5-minute observations during the last half of the survey period. Those observations included 37 birds and 65 bats.

### 2.3.5 Weather Data

Mean nightly wind speeds in the Project area from May 1 to June 3 ranged between 2.4 and 10.5 meters per second (m/s). Mean nightly temperatures varied between -1.3ºC and 11.1ºC.

### 2.3.6 NEXRAD Analysis

A total of 55 nights of NEXRAD data were analyzed from April 15 to June 15, 2008, dates considered to be the typical spring migration period. Detectable biological activity occurred on 44 of those nights, with 9 nights of no detectable biological activity due to prolonged intense rain and 2 nights where NEXRAD data was not available. There were 11 nights of light biological activity and 33 nights of moderate to heavy nights of biological activity. Moderate to heavy nights of biological activity indicated a distinct migration event was occurring, and were distinguished from nights of light activity when the type of biological activity was less distinct or apparent. Overall, NEXRAD data documented a greater proportion (60 percent) of nights with moderate to heavy biological activity. Likewise, during the 20 nights of on-site radar surveys, a greater proportion (62 percent) of sampling also occurred on nights with moderate to heavy biological activity (Table 2-1).

**Table 2-1.** Summary of NEXRAD and on-site radar data collection

| Migration Activity Category | Number of nights (NEXRAD) | Percent of Migration Nights | Number of nights with on-site radar | Percent of on-site radar data set |
|---|---|---|---|---|
| Rain | 9 | 16% | 3 | 14% |
| Light Migration | 11 | 20% | 4 | 19% |
| Moderate to Heavy Migration | 33 | 60% | 13 | 62% |
| Not Available | 2 | 4% | 1 | 5% |

## 2.4 DISCUSSION

Considerable nightly variation in the magnitude and flight characteristics of nocturnally-migrating songbirds is typical and is often attributed to weather patterns, such as cold fronts and winds aloft (Hassler *et al.* 1963, Gauthreaux and Able 1970, Richardson 1972, Able 1973, Bingman *et al.* 1982, Gauthreaux 1991). Data from regional surveys using similar methods and equipment conducted within the last several years are rapidly becoming available, thus allowing an opportunity to compare the results from this area to other projects in the area. There are, however, limitations in comparing data from previous years with data from 2008, as year-to-year variation in continental bird populations may influence how many birds migrate through an area. Additionally, differences in site characteristics, particularly topography, local landscape conditions, and vegetation surrounding a radar survey location, can play a large role in any radar's ability to detect targets and the subsequent calculation of passage rate. These differences should be recognized as significant limiting factors in making direct site-to-site comparisons in passage rates.

Regardless of potential differences between radar survey locations, the nightly mean passage rates observed at the Project (498 t/km/hr) were within the upper range of other available studies that have been conducted to date within the local region (Table 2-2). There is currently no accurate quantitative method of directly correlating pre-construction passage rates at wind farms to operational impacts to birds and bats. Some research suggests that bird migration may be affected by landscape features, such as coastlines, large river valleys, and mountain ranges. This has been documented for diurnally migrating birds, such as raptors, but is not as well established for nocturnally migrating birds (Sielman *et al*. 1981; Bingman 1980; Bingman *et al*. 1982; Bruderer and Jenni 1990; Richardson 1998; Fortin *et al*. 1999; Williams *et al.* 2001; Diehl *et al*. 2003). However, studies suggesting night-migrating birds are influenced by

topography have typically been conducted in areas of steep topography, such as the most rugged areas of the northern Appalachians and the Alps.

An emerging body of studies characterizing nocturnal bird movements shows a relatively consistent pattern in flight altitude, with most birds' flight occurring at altitudes of several hundred meters or more above the ground. Comparison of radar-derived flight height between survey sites as measured by radar is generally less influenced by site characteristics as the main portion of the radar beam is directed skyward, and the potential effects of surrounding vegetation on the radar's view can be more easily controlled. The range in mean flight heights is approximately 300 m (1,000') to 600 m (2,000') above the radar site. The percentage of targets documented at heights below the maximum turbine height is variable, but is typically within the range of 10 to 20 percent. The flight height documented in the Project area (276 m, 905') is within the range of other studies in the region. While the observed percentage of targets flying below the maximum turbine height was relatively high (21%), it was within the range of other local studies. The radar view in the Project area was also very good and included an easterly view shed that dropped approximately 122m (400') below the ridgeline elevation. Birds traveling thru the eastern valley would have been included in the radar viewshed and subsequently incorporated into the analysis.

### 2.5 CONCLUSIONS

Radar surveys during the spring 2008 migration period have provided important information on nocturnal bird migration patterns in the vicinity of the Project area. The results of the surveys indicate that bird migration patterns are generally similar to patterns observed at other sites in the northeastern U.S. region, especially other sites in Maine.

Migration activity varied throughout the season, which is likely largely attributable to weather patterns. The mean passage rate is generally within the upper range of passage rates observed at other regional sites studied with similar methods and equipment. The combination of the flight height and flight direction data indicates that the majority of migrants are unimpeded by topography and flying at significantly high elevations (relative to the proposed turbines and blade heights) and in a broadfront flight pattern.

## 3.0 Acoustic Bat Survey

Eight species of bats occur in Maine, based upon their normal geographical range. These are the little brown bat (*Myotis lucifugus*), northern long-eared bat, (*M. septentrionalis*), eastern small-footed bat (*M. leibii*), silver-haired bat (*Lasionycteris noctivagans*), eastern pipistrelle (*Perimyotis* = [*Pipistrellus*] *subflavus*), big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), and hoary bat (*L. cinereus*) (BCI 2001). Of these, four are listed as species of Special Concern in Maine, including the small-footed bat, silver-haired bat, eastern red bat, and hoary bat. All but the eastern small-footed bat are believed to occur in most of the state;

the eastern small-footed bat is believed to be rare, but population size and trends are not well known for this species.

## 3.1 INTRODUCTION

To document bat activity patterns in the Project area, Stantec conducted acoustic monitoring surveys with Anabat detectors during spring and summer 2008, the second and third seasons of data collection at the Project. Acoustic bat detectors allow for long-term monitoring of activity patterns of bats in a variety of habitats, including the air space approaching the rotor-swept zone of modern wind turbines. The acoustic bat survey at Oakfield was designed to document bat activity patterns at various heights and in various locations throughout the Project area. Acoustic surveys were also intended to document bat activity patterns in relation to weather factors including wind speed, temperature, and relative humidity.

## 3.2 METHODS

### 3.2.1 Field Surveys

Four Anabat II and two SD 1 detectors (Titley Electronics Pty Ltd.) were used for the duration of the spring and summer 2008 acoustic bat surveys. Anabat detectors were selected based upon their widespread use for this type of survey, their ability to be deployed for long periods of time, and their ability to detect a broad frequency range, which allows detection of all species of bats that could occur in the Project area. Anabat detectors are frequency division detectors, dividing the frequency of ultrasonic calls made by bats by a factor of 16 so that they are audible to humans, which record the bat calls for subsequent analysis. The audio sensitivity setting of each Anabat system was set at between six and seven (on a scale of one to ten) to maximize sensitivity while limiting ambient background noise and interference. The sensitivity of individual detectors was then tested using an ultrasonic Bat Chirp (Reno, NV) to ensure that the detectors would be able to detect bats up to a distance of at least 10 m (33'). Each Anabat detector was coupled with CF Storage ZCAIM (Titley Electronics Pty Ltd.), which programmed the on/off times and stored data on removable 1 GB compact flash cards.

Detectors were powered by 12-volt batteries charged by solar panels. Each solar-powered Anabat system was deployed in a waterproof housing enabling the detector to record while unattended for the duration of the survey. The housing is designed to suspend the Anabat microphone downward to give maximum protection from precipitation. To compensate for the downward position, a reflector shield of smooth plastic is placed at a 45-degree angle directly below the microphone. The angled reflector allows the microphone to record the airspace horizontally surrounding the detector and is only slightly less sensitive than an unmodified Anabat unit. Maintenance visits were conducted approximately every two weeks to check on the condition of the detectors and to download the collected data to a computer for analysis.

Six bat detectors were deployed between April 25 to May 31 (spring) and between June 1 and August 11 (summer). Detectors were positioned in the proposed turbine areas along the ridge top that enabled comparative sampling of bat populations and bat activities directly within the

local forest canopy as well as in the air space above the forest canopy, within the lower elevations of the rotor zone. Detectors were programmed to continuously record data from 7:00 pm to 7:00 am each night.

In the spring, two detectors were deployed in an existing met tower on the summit of Sam Drew Mountain and four detectors were deployed in trees throughout the Project area (Figure 1-1). During a portion of the summer survey, three of the tree detectors were moved to new met towers located throughout the Project area. The met tower detectors were placed at approximately 11 m (35') and 22 m (70') above the ground to survey near the proposed wind turbine rotor zone. The tree detectors were typically hung 3-5 m (10-16') from the ground and aimed to record activity within an opening in the forest canopy.

The Radar Tree Detector was positioned approximately 15' high in a sugar maple immediately over a fringe of high shrub vegetation (Photo 3-1). The tree itself was situated along the edge of a narrow woods road, adjacent to a former log landing that contained the met tower and radar location site. The detector microphone was targeted along the road edge and down along a relatively narrow (8-10') road corridor bordered by high deciduous saplings and trees. Vegetation along the road corridor edges and adjacent radar site clearing was irregular and varied from 20 to 30 feet in height with numerous gaps. Vegetation within the adjacent clearing was dominated by thick maple coppice sprouts and Rubus spp., and generally varying from 3 to 5 feet in height.

**Photo 3-1.** Radar tree detector.

The North Tree Detector was positioned approximately 16' high in a dead, balsam fir snag, situated at the edge of a clump of mixed trees within a large, clearcut opening (Photo 3-2). The opening was largely dominated by high grasses and mixed herbaceous vegetation and included

clearings associated with a road crossings. Vegetation surrounding the clearing was largely dead and pole sized spruce and fir, with scattered birch and mixed hardwoods.

**Photo 3-2.** North tree detector.

The Road Tree Detector was positioned approximately 13' high in a paper birch pole over a narrow band of red spruce and birch high saplings at the edge of a former woods road landing site (Photo 3-3). The detector was located approximately mid-height of the local canopy; other tree and high pole vegetation around the clearing generally varied from 25 to 35 feet in height and was composed almost exclusively of deciduous, northern hardwoods. The adjacent clearing was approximately 0.3 acres in size and open, with only low herbaceous and grass species. The tree edge microphone was pointed directly into the clearing.

**Photo 3-3.** Road tree detector.

### 3.2.2 Data Analysis

Potential call files were extracted from data files using CFCread© software. The default settings for CFCread© were used during this file extraction process, as these settings are recommended for the calls that are characteristic of northeastern bats. This software screens all data recorded by the bat detector and extracts call files using a filter. Using the default settings for this initial screen also ensures comparability between data sets. Settings used by the filter include a max TBC (time between calls) of 5 seconds, a minimum line length of 5 milliseconds, and a smoothing factor of 50. The smoothing factor refers to whether or not adjacent pixels can be connected with a smooth line. The higher the smoothing factor, the less restrictive the filter is and the more noise files and poor quality call sequences are retained within the data set. A call is a single pulse of sound produced by a bat. A call sequence is a combination of two or more pulses recorded in a call file. Understanding the parameters of these settings is important in terms of determining when individual calls are classified as "unknown".

Following extraction of call files, each file was visually inspected to ensure that files created by static or some other form of interference that were still within the frequency range of Maine bats were not included in the data set. Bat calls typically include a series of pulses characteristic of normal flight or prey location ("search phase" calls) and capture periods (feeding "buzzes") and visually look very different than static, which typically forms a diffuse band of dots at either a constant frequency or widely varying frequency, caused by wind, vibration, or other interference. Using these characteristics, bat call files are easily distinguished from non-bat files.

Bat call sequences were individually marked and categorized by species group, or "guild" based on visual comparison to reference calls. Qualitative visual comparison of recorded call sequences of sufficient length to reference libraries of bat calls allows for relatively accurate identification of bat species (O'Farrell *et al*. 1999, O'Farrell and Gannon 1999). A call sequence was considered of suitable quality and duration if the individual call pulses were "clean" (i.e., consisting of sharp, distinct lines) and at least five pulses were included within the sequence. Call sequences were classified to species whenever possible, based on criteria developed from review of reference calls collected by Chris Corben, the developer of the Anabat system, and other bat researchers. However, due to similarity of call signatures between several species, all classified calls have been categorized into guilds[3] reflecting the bat community in the region of the Project area and is as follows:

- **Unknown (UNKN)** – All call sequences with too few pulses (less than five) or of poor quality (such as indistinct pulse characteristics or background static). These calls were further identified as either "high frequency unknown" (HFUN) for calls above 30kHz or "low frequency unknown" (LFUN) for calls below 30kHz;

- **Myotid (MYSP)** – All bats of the genus *Myotis*. While there are some general characteristics believed to be distinctive for several of the species in this genus, these

[3] Gannon *et al.* 2003 categorized bats into guilds based upon similar minimum frequency and call shape. These guilds were: Unidentified, Myotis, LABO-PISU and EPFU-LANO-LACI.

characteristics do not occur consistently enough for any one species to be relied upon at all times when using Anabat recordings;

- **Red bat/pipistrelle (RBEP)** – Eastern red bats and eastern pipistrelles. These two species can produce calls distinctive only to each species. However, significant overlap in the call pulse shape, frequency range, and slope can also occur; and;

- **Big brown/silver-haired/hoary bat (BBSHHB)** – This guild will be referred to as the big brown guild. These species' call signatures commonly overlap and have therefore been included as one guild in this report.

This guild grouping represents the most conservative approach to bat call identification (Hayes 2000). Since some species do sometimes produce calls unique only to that species, all calls were identified to the lowest possible taxonomic level before being grouped into the listed guilds. Tables and figures in the body of this report will reflect those guilds. However, since species-specific identification did occur in some cases, each guild will also be briefly discussed with respect to potential species composition of recorded call sequences.

Once all of the call files were identified and categorized in appropriate guilds, nightly tallies of detected calls were compiled. Mean detection rates (number of calls/detector-night) for the entire sampling period were calculated for each detector and for all detectors combined. It is important to note that detection rates indicate only the number of calls detected and do not necessarily reflect the number of individual bats in an area. For example, a single individual can produce one or many call files recorded by the bat detector, but the bat detector cannot differentiate between individuals of the same species producing those calls. Consequently, detections recorded by the bat detector system likely over-represent the actual number of animals that produced the recorded calls.

### 3.2.3 Radar, Ceilometer, and Night-vision Goggle Observations

Ceilometer surveys were also conducted concurrently with the acoustic bat monitoring on 20 nights during the spring sampling period. In addition, use of night-vision goggles, combined with red filtered flood lights, provided an excellent opportunity to view the air space immediately around the radar location. The experimental use of the goggles was introduced midway during the survey period, but once available, were used on an hourly basis much as the ceilometer surveys. While conclusive differentiation between bats and birds is not possible using radar, work conducted by Stantec during previous studies using radar, night-vision goggles, and thermal imaging cameras indicates that nocturnal targets that move erratically or in curving paths are typically bats, while those with straight flight paths are birds. Additionally, while bats can create radar flight paths more similar to birds (i.e., straight flight path), no birds were

observed creating the erratic radar flight paths observed to be created by some bats (Woodlot, unpublished observations)[4].

Targets with erratic flight paths, similar to those previously observed to be created by bats were noted during the analysis of the radar video data. Nightly tallies of these targets were then made. Additionally, the night-vision goggle observations made during the radar survey were an opportunity to document birds and bats flying at low altitude over the radar site and to better distinguish birds and bats from moths and other large flying insects. Any bats observed during the night-vision surveys were recorded.

### 3.2.4 Weather Data

Weather data was collected from an anemometer on the met tower at the summit of Sam Drew Mountain between April 25 and August 11. Additional data was also collected from a weather station deployed by Stantec at the radar site during the spring survey period. For reporting purposes, wind direction and wind speed was recorded by the anemometer. Temperature and humidity was recorded by data loggers (HOBO Pro v2 U23-001, Onset Computer Corporation). The mean wind direction, wind speed, temperature, and humidity were calculated for each night.

## 3.3 RESULTS

### 3.3.1 Detector Call Analysis

For the spring survey, six detectors were deployed April 25 and continued to record data through May 31, for a total survey period of 37 nights. For the summer survey, six detectors recorded data from June 1 through August 11 for a total summer survey period of 72 nights. The range of dates that each detector was deployed is summarized in Table 3-1 and Table 3-2. Occasional data gaps occurred when detectors powered down during the survey period. Although the North Tree detector functioned normally in the spring, a computer hardware malfunction precluded successful data downloads from this detector. To account for these periods, the number of detector-nights is reported for each detector. Combined, the six detectors at Oakfield sampled a total of 158 detector-nights during the spring survey period and a total of 407 detector-nights during the summer survey period.

During the spring, a total of 600 bat call sequences were recorded (Table 3-1). Excluding the North Tree detector, the number of call sequences recorded by each detector ranged from 3 at the Radar High detector to 261 at the South Tree detector. The overall mean detection rate for all six detectors was 3.8 calls/detector-night. Detection rates at each of the tree detectors ranged from 3.4 calls/detector-night at the Road Tree detector to 9.1 calls/detector-night at the Radar Tree detector, for an overall mean detection rate among the tree detectors of 6.8 calls/detector-night. The maximum number of call sequences recorded in one night ranged

[4] All field work and any reporting and permitting activities performed prior to October 1, 2007, were conducted as Woodlot Alternatives, Inc. and will be herein referenced as work done by Woodlot. Stantec Consulting Services, Inc. formally merged with Woodlot Alternatives, Inc. on October 1, 2007. Work conducted on or after October 1, 2007 is herein referenced as work done by Stantec.

from 24 at the Road Tree detector to 60 at the Radar Tree detector. No calls were recorded by the Radar High detector after May 16.

**Table 3-1.** Summary of bat detector field survey effort and results - Spring 2008.

| Location | Dates | # Nights | # Detector-Nights* | # Recorded sequences | Detection Rate ** | Maximum # calls recorded *** |
|---|---|---|---|---|---|---|
| Radar Met High | 4/25-5/31 | 37 | 36 | 3 | 0.1 | 2 |
| Radar Met Low | 4/25-5/31 | 37 | 36 | 13 | 0.4 | 2 |
| Radar Tree | 4/25-5/31 | 37 | 24 | 218 | 9.1 | 60 |
| North Tree | 4/28-5/29 | 33 | 0 | 0 | 0.0 | 0 |
| South Tree | 5/1-5/31 | 31 | 31 | 261 | 8.4 | 58 |
| Road Tree | 5/1-5/31 | 31 | 31 | 105 | 3.4 | 24 |
| | ***Overall Results Met*** | ***74*** | ***72*** | ***16*** | ***0.2*** | -- |
| | ***Overall Results Tree*** | ***132*** | ***86*** | ***584*** | ***6.8*** | -- |
| ***Overall Results Combined*** | | ***206*** | ***158*** | ***600*** | ***3.8*** | |

* Detector-night is a sampling unit during which a single detector is deployed overnight. On nights when two detectors are deployed, the sampling effort equals two detector-nights, etc.

** Number of bat passes recorded per detector-night.

*** Maximum number of bat passes recorded from any **single** detector for a 12-hour sampling period.

During the summer, a total of 6013 bat call sequences were recorded (Table 3-2). The number of call sequences recorded by each detector ranged from 3 (North Met High) to 4452 (Radar Tree). The overall mean detection rate for all six detectors in nine locations was 15.0.

Detection rates at each of the four tree detector locations ranged from 2.0 calls/detector night at the North Tree detector to 61.8 calls/detector-night at the Radar Tree detector, for an overall mean detection rate among the tree detectors of 30.5 calls/detector night. The maximum number of call sequences recorded in one night ranged from 21 at North Tree detector to the 693 at the Radar Tree detector.

Detection rates at each of the five met tower detector locations ranged from 0.1 calls/detector night at the North Met High detector to 1.8 calls/detector night at the Radar Met Low detector, for an overall mean detection rate among met tower detectors of 1.1 calls/detector night. The maximum number of call sequences recorded in one night ranged from 1 at the North Met High detector to 32 at the Radar Met High detector.

**Table 3-2.** Summary of bat detector field survey effort and results - Summer 2008.

| Location | Dates | # Nights | # Detector-Nights* | # Recorded sequences | Detection Rate ** | Maximum # calls recorded *** |
|---|---|---|---|---|---|---|
| Radar Met High | 6/1-8/11 | 72 | 47 | 68 | 1.4 | 32 |
| Radar Met Low | 6/1-8/11 | 72 | 72 | 129 | 1.8 | 19 |
| Radar Tree | 6/1-8/11 | 72 | 72 | 4452 | 61.8 | 693 |
| North Tree | 6/1-7/10 | 40 | 40 | 79 | 2.0 | 21 |
| South Tree | 6/1-7/10 | 40 | 40 | 1164 | 29.1 | 277 |
| Road Tree | 6/1-7/10 | 40 | 40 | 166 | 4.2 | 25 |
| North Met High | 7/11-8/11 | 32 | 32 | 3 | 0.1 | 1 |
| North Met Low | 7/11-8/11 | 32 | 32 | 9 | 0.3 | 2 |
| South Met High | 7/11-8/11 | 32 | 32 | 33 | 1.0 | 18 |
| ***Overall Results Met*** | | ***240*** | ***215*** | ***242*** | ***1.1*** | -- |
| ***Overall Results Tree*** | | ***192*** | ***192*** | ***5861*** | ***30.5*** | -- |
| ***Overall Results Combined*** | | ***432*** | ***407*** | ***6103*** | ***15.0*** | -- |

* Detector-night is a sampling unit during which a single detector is deployed overnight. On nights when two detectors are deployed, the sampling effort equals two detector-nights, etc.

** Number of bat passes recorded per detector-night.

*** Maximum number of bat passes recorded from any **single** detector for a 12-hour sampling period.

Overall, peak numbers of call sequences were primarily recorded in mid June for the met tower detectors (Figure 3-1) and early July for the tree detectors (Figure 3-2). All four tree detectors recorded peak levels of activity during early July, although smaller peaks were also recorded at other times. The Radar Tree detector recorded peak levels of calls during the first two weeks of July, with a smaller peak in mid-June; peaks were typically more than 200 calls per night. The South Tree detector also recorded a peak in early July, with smaller peaks in mid-June, with two nights of approximately 80 calls. Peaks for the Road Tree detector were recorded during mid-May, mid-June, and early July although no nights recorded more than 25 calls.

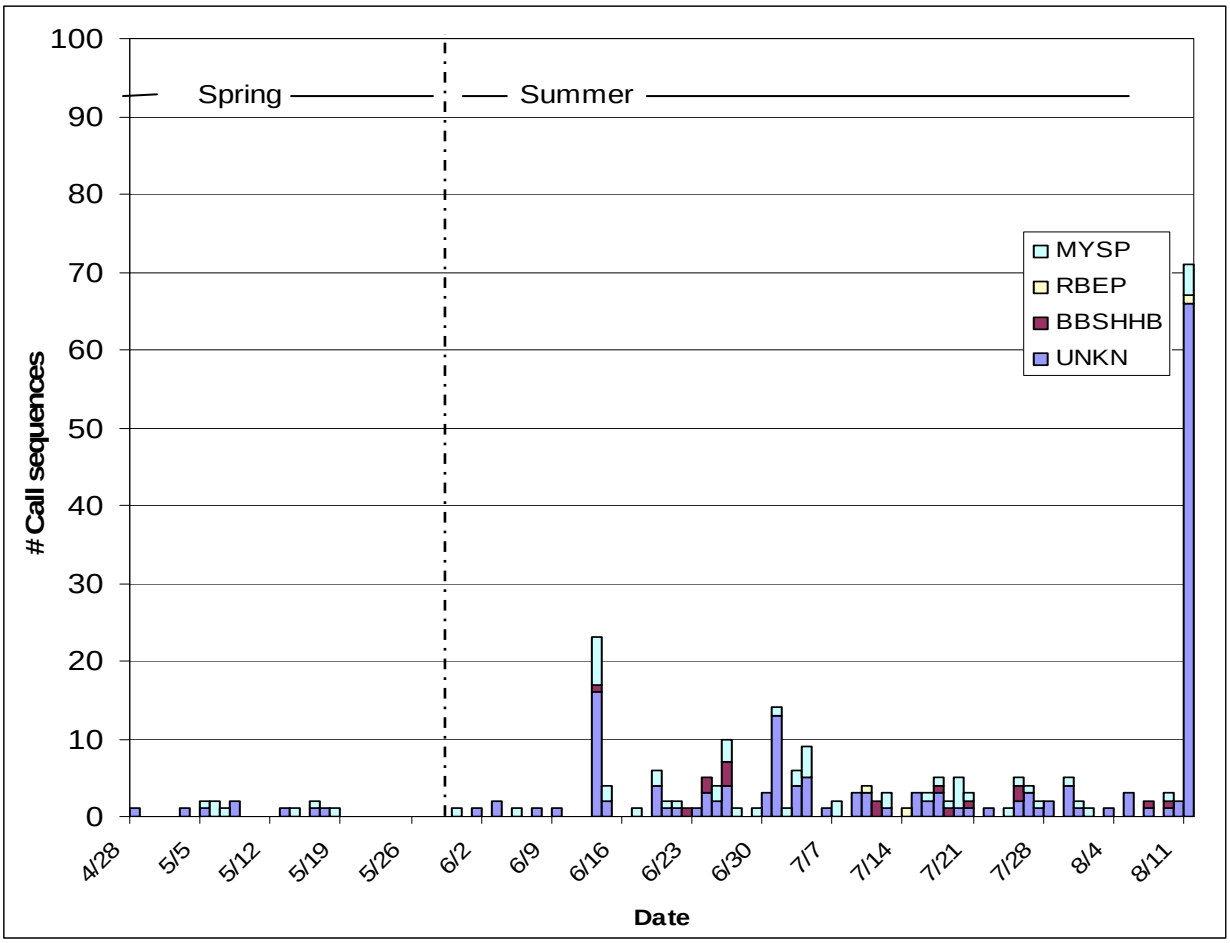


**Figure 3-1.** Guild composition of total nightly bat call sequence detections (n = 258) recorded at met tower detectors during the spring and summer 2008 survey periods.

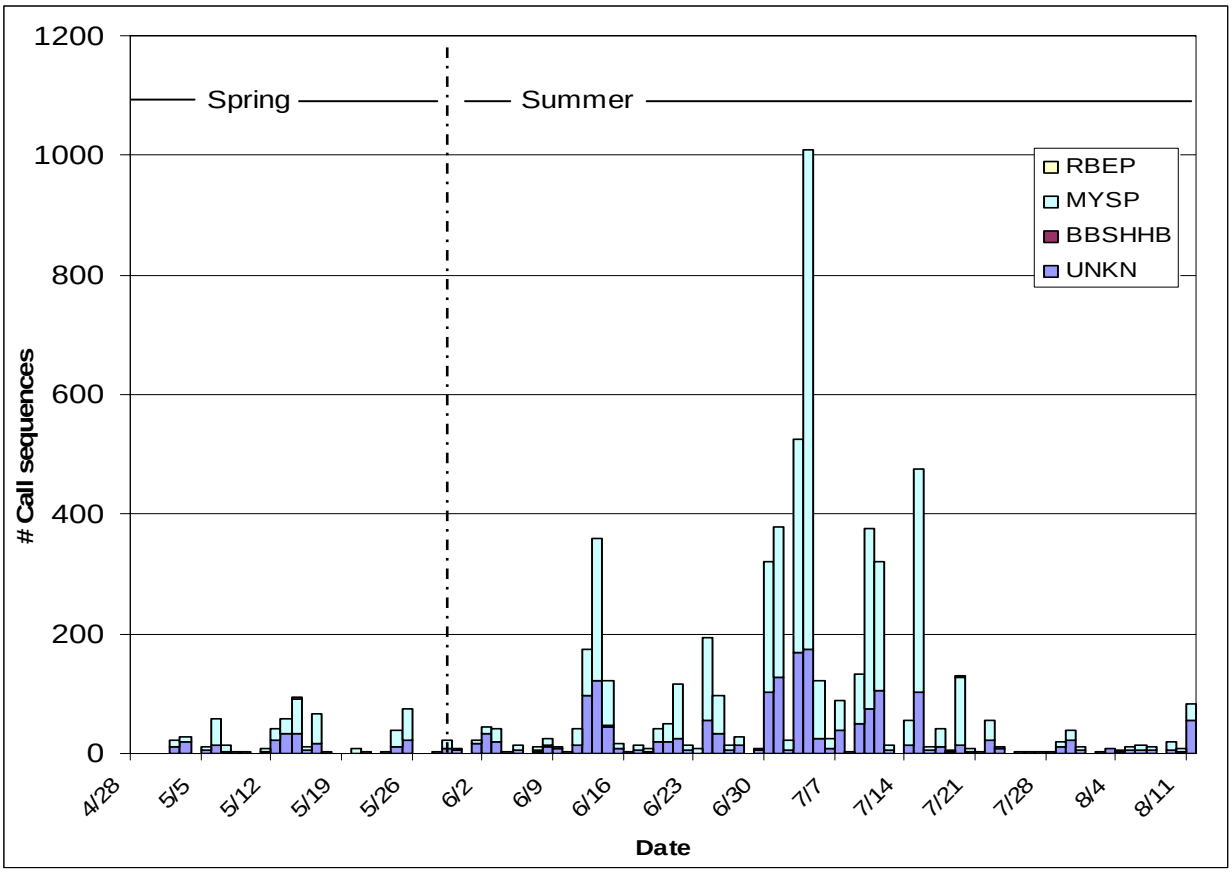


**Figure 3-2.** Guild composition of total nightly bat call sequence detections (n = 6445) recorded at tree detectors during the spring and summer 2008 survey periods.

Calls from the MYSP and UNKN guilds were primarily responsible for the peaks in call volume throughout both seasons.

In the spring, some of the recorded call sequences (38%) were labeled as unknown due to very short call sequences (less than five pulses) or poor call signature formation (probably due to a bat flying at the edge of the detection zone of the detector or flying away from the microphone; Table 3-3). Of the calls that were identified to species or guild, those of the MYSP guild were the most common (62% of all call sequences), followed by the species within the RBEP guild (0.3% of all call sequences) and the BBSHHB guild (0.2%). Of the calls recorded at each detector identified to guild, those of the MYSP guild were the most common, and in most cases made up more than 40 percent of all calls. At each detector, calls within the UNKN group made up approximately one quarter to half of all calls recorded.

**Table 3-3.** Summary of the composition of recorded bat call sequences - Spring 2008.

| Detector | Guild | | | | Total |
|---|---|---|---|---|---|
| | Big brown guild | Red bat/ E. pipistrelle | Myotis | Unknown | |
| Radar Met High | 0 | 0 | 0 | 3 | 3 |
| Radar Met Low | 0 | 0 | 8 | 5 | 13 |
| Radar Tree | 0 | 0 | 166 | 52 | 218 |
| North Tree | 0 | 0 | 0 | 0 | 0 |
| South Tree | 0 | 2 | 146 | 113 | 261 |
| Road Tree | 1 | 0 | 52 | 52 | 105 |
| ***Overall Results Met*** | ***0*** | ***0*** | ***8*** | ***8*** | ***16*** |
| ***Overall Results Tree*** | ***1*** | ***2*** | ***364*** | ***217*** | ***584*** |
| ***Grand Total*** | ***1*** | ***2*** | ***372*** | ***225*** | ***600*** |
| ***Species composition (%)*** | ***<1%*** | ***<1%*** | ***62%*** | ***38%*** | |

In the summer, some of the recorded call sequences (32%) were labeled as unknown due to very short call sequences (less than five pulses) or poor call signature formation (probably due to a bat flying at the edge of the detection zone of the detector or flying away from the microphone; Table 3-3). Of the calls that were identified to species or guild, those of the MYSP guild were the most common (68% of all call sequences), followed by the species within the RBEP guild (0.4% of all call sequences) and the BBSHHB guild (0.1%). Of the calls recorded at each detector identified to guild, those of the MYSP guild were the most common and comprised 40 to 80 percent of all calls.

**Table 3-4.** Summary of the composition of recorded bat call sequences - Summer 2008.

| Detector | Guild | | | | Total |
|---|---|---|---|---|---|
| | Big brown guild | Red bat/ E. pipistrelle | Myotis | Unknown | |
| Radar Met High | 5 | 0 | 12 | 51 | 68 |
| Radar Met Low | 4 | 1 | 38 | 86 | 129 |
| Radar Tree | 1 | 3 | 3,000 | 1448 | 4,452 |
| North Tree | 3 | 0 | 36 | 40 | 79 |
| South Tree | 3 | 0 | 962 | 199 | 1,164 |
| Road Tree | 2 | 0 | 71 | 93 | 166 |
| North Met High | 0 | 0 | 0 | 3 | 3 |
| North Met Low | 3 | 1 | 1 | 4 | 9 |
| South Met High | 4 | 1 | 2 | 26 | 33 |
| ***Overall Results Met*** | **16** | **3** | **53** | **170** | **242** |
| ***Overall Results Tree*** | **9** | **3** | **4069** | **1780** | **5861** |
| ***Grand Total*** | ***25*** | ***6*** | ***4122*** | ***1950*** | ***6103*** |
| ***Species composition (%)*** | **0%** | **0%** | **68%** | **32%** | **100%** |

In the spring, overall nightly activity showed a peak between 8:00 pm and 9:00 pm (20:00 and 21:00; Figure 3-3). Peaks in overall activity were relatively consistent at an individual detector level, but with some relatively minor fluctuations of hourly peak use between the various detectors.

In the summer, overall nightly activity showed a peak between 1:00 am and 2:00 am (Figure 3-4) and no calls were recorded after 4:00 am.

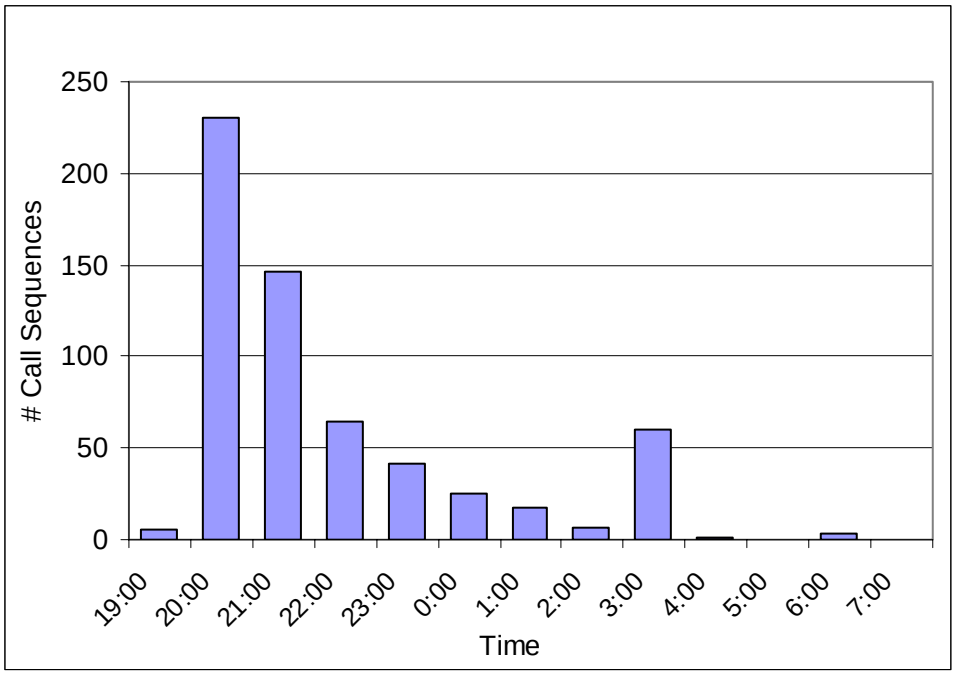


**Figure 3-3**. Nightly timing of recorded bat activity for all detectors deployed during spring 2008.

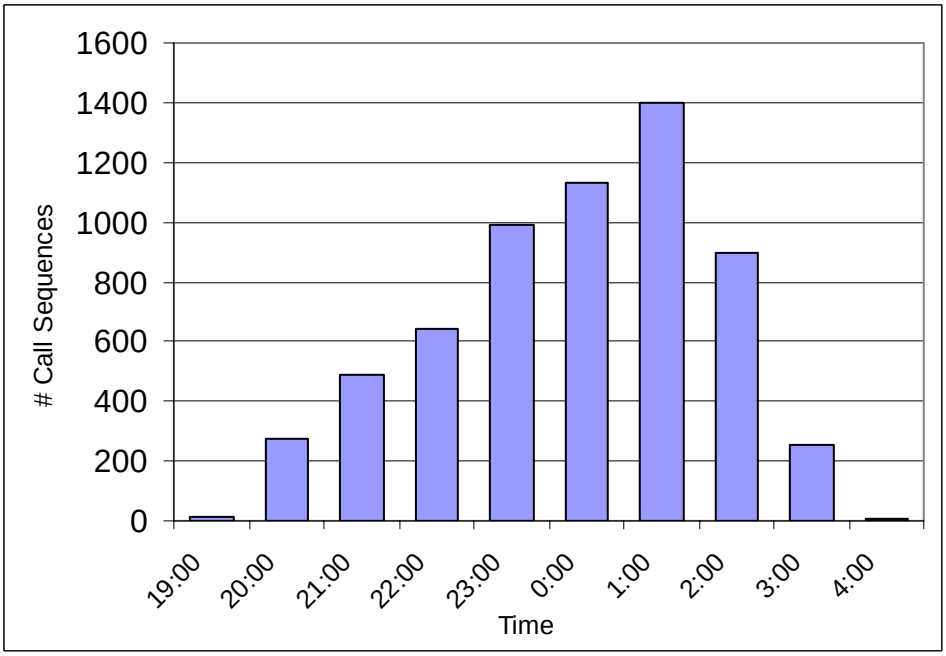


**Figure 3-4**. Nightly timing of recorded bat activity for all detectors deployed during summer 2008.

Appendix B provides a series of tables with more specific information on number of call sequences, by guild and suspected species, recorded at each detector and the weather conditions for that night. The actual data file information for each of the detectors and all recorded call sequences can be provided upon request.

### 3.3.2 Radar, Ceilometer and Night-vision Goggle Observations

During radar surveys conducted in the spring period, 65 bats were observed during the course of 54 five-minute ceilometer observation periods. During analysis of the radar survey video data, 0.1% of target trails were identified as potential bats (Appendix A, Table 5). These observations were generally distributed throughout the sampling period. No correlations between the total number of recorded bat call sequences and ceilometer, radar target, or radar passage rates were observed. The use of night vision goggles enabled more qualitative observations but these were not quantified due to the late season start.

### 3.3.3 Weather Data

In the spring (April 25 to May 31), mean nightly wind speeds in the Project area varied between 2.4 and 11.3 meters per second (m/s), with an overall mean of 7.5 m/s (Figure 3-5). Mean nightly temperatures varied between -2.3ºC and 11.4ºC, with an overall mean of 6.3ºC (Figure 3-6). Bat call activity at each detector did not correlate strongly with temperature, wind speed or relative humidity.

In the summer (June 1 to August 11), mean nightly wind speeds varied between 2.4 and 11.9 m/s, with an overall mean of 6.6 m/s (Figure 3-7). Mean nightly temperatures varied between 8.0ºC and 21.6ºC, with an overall mean of 14.9ºC (Figure 3-8). Bat call activity at each detector did not correlate strongly with temperature, wind speed or relative humidity.

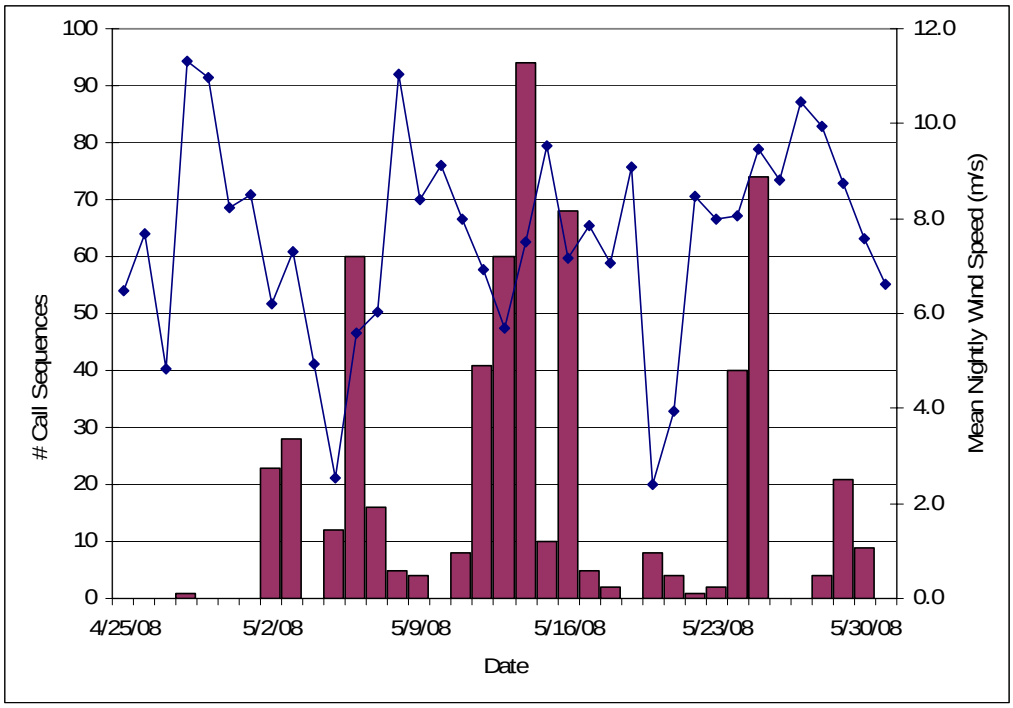


**Figure 3-5.** Nightly mean wind speed (m/s) (blue line) and bat call detections in spring 2008

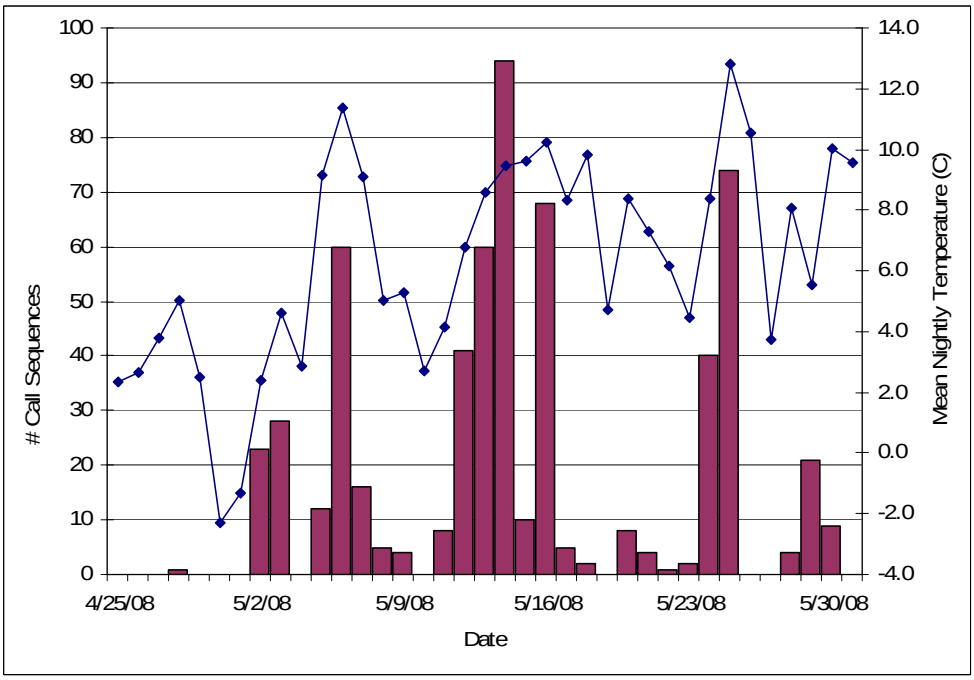


**Figure 3-6.** Nightly mean temperature (Celsius) (blue line) and bat detections in spring 2008

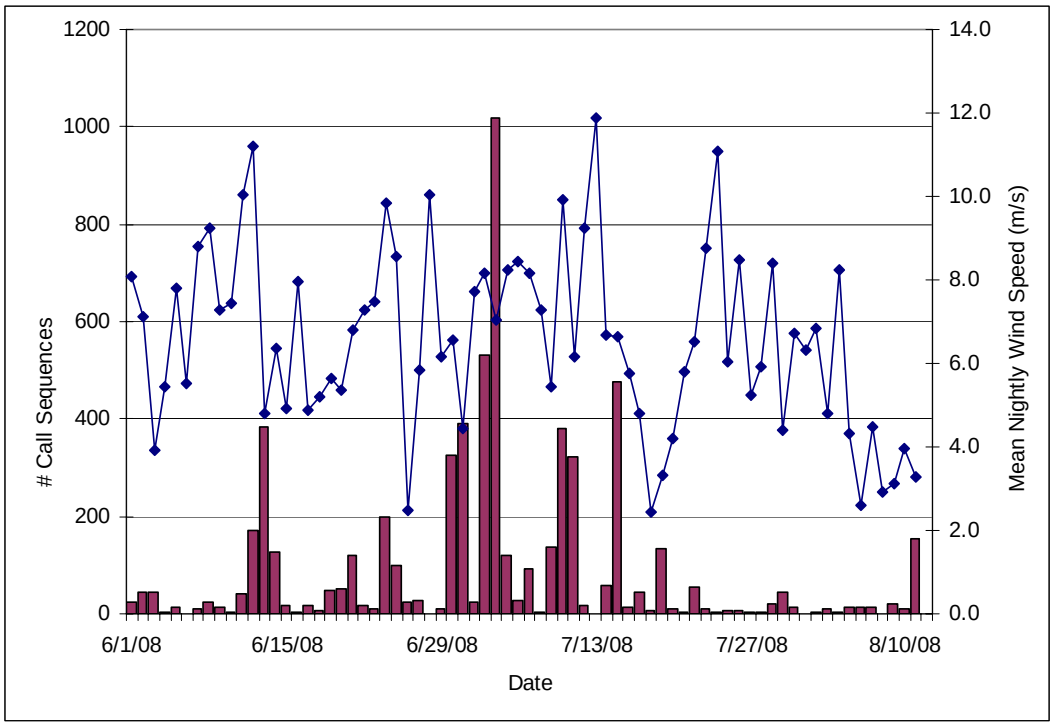


**Figure 3-7.** Nightly mean wind speed (m/s) (blue line) and bat call detections in summer 2008

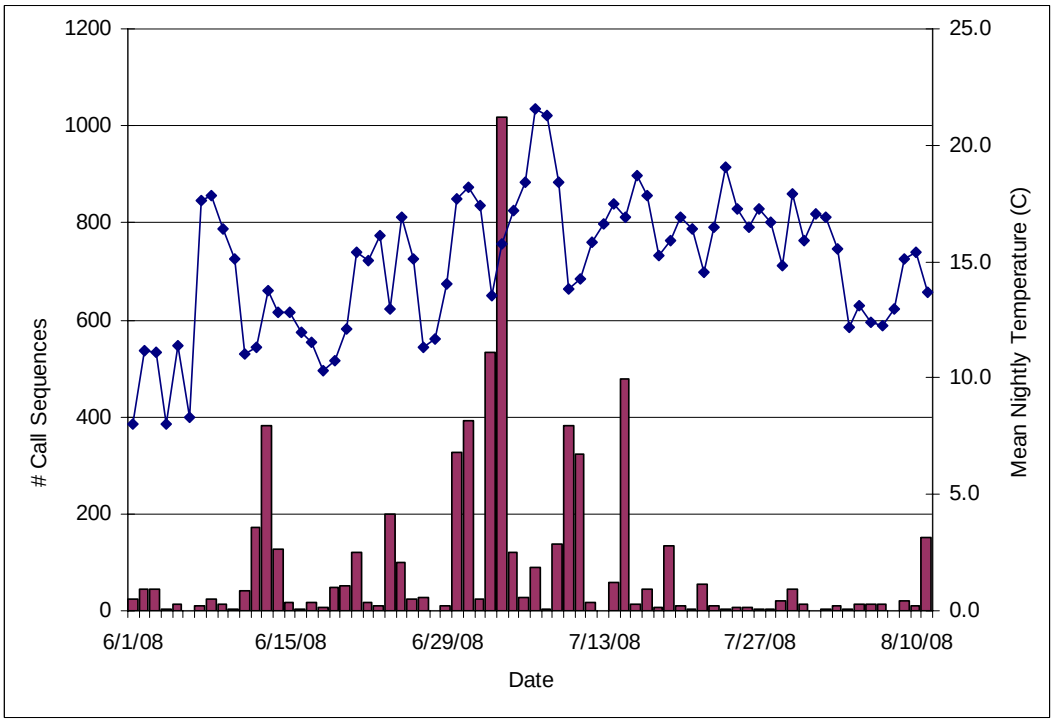


**Figure 3-8.** Nightly mean temperature (Celsius) (blue line) and bat detections in summer 2008

## 3.4 DISCUSSION

Bat echolocation surveys in spring and summer 2008 provide some insight into activity patterns, possible species composition, and timing of movements of bats in the Project area. Bat activity was variable among nights at all nine acoustic sampling locations. Peak call sequence detections occurred during early July with isolated peaks during mid-May and mid-June, and did not appear to correlate with temperature, relative humidity or wind speed. Overall nightly activity peaked at 8:00 pm in the spring and 2:00 am in the summer. The most common call sequences recorded were those of the MYSP and UNKN guilds. The overall mean detection rate during the spring survey period was 3.8 calls/detector-night. This rate is within range of other spring bat detector surveys conducted recently within the area (Appendix C Table 14).

In both seasons, the Radar Tree and South Tree detectors recorded the majority of calls in the Project area. In the summer, the Radar Tree detector recorded 73 percent of all calls, and 62 percent of the calls at this detector were recorded during the first two weeks of July. Additionally, all but two of the calls during those two weeks were of the genus Myotis or were high-frequency unknown (which are more likely to be of the genus Myotis). Myotis are known to typically forage at lower heights and are thought to use man-made and natural openings below the forest canopy for travel or foraging. Because these bat detectors were located in potential travel corridors used for foraging, it is possible that numerous call sequences could be from the same individual bat or group of bats traveling or foraging along the trails (Arnett et al. 2006). These activity patterns likely account for the higher detection rate at these detectors. Detector placement with regards to height and clutter[5] may also influence the number of detections at a detector (Weller and Zabel 2002). The potential influences of detector location, orientation and height were not teased apart in this survey.

Bat calls were identified to guild within this report, although calls were provisionally categorized by species when possible during analysis. Certain species, such as the eastern red bat and hoary bat have easily identifiable calls, whereas other species, such as the big brown bat and silver-haired bat are difficult to distinguish acoustically. Similarly, certain members of the genus *Myotis*, such as the little brown bat are far more common and have slightly more distinguishable calls than other species. The following paragraphs discuss each guild separately and address likely species composition of recorded bats within each guild.

The MYSP guild includes all three species of *Myotis* potentially occurring in the Project area, including the little brown bat, northern long-eared bat, and the eastern small-footed bat. Of these species, the little brown bat and northern long-eared bat are by far the most common, and have calls that tend to be slightly more distinguishable using the Anabat system. *Myotis* species were most common at this site overall and were recorded by every detector except the North

[5] Here clutter is defined as obstacles in the environment such as understory vegetation or tree trunks which may obscure or block ultrasonic signals between a bat and the microphone of the bat detector (Weller and Zabel 2002).

Met High detector. Calls were not diagnostic of any of the three *Myotis* species. Most calls were of weak signal strength.

The RBEP guild includes the eastern pipistrelle and eastern red bat. Eastern red bats have relatively unique calls which span a wide frequency range and have a characteristic hooked shape and variable minimum frequency. Eastern pipistrelles tend to have relatively uniform calls, with a constant minimum frequency and a sharply curved profile. Of the eight sequences classified as RBEP, both were likely eastern red bat sequences as eastern pipistrelles tend to be solitary foragers, often feeding over water and emerging around sunset. Conversely, eastern red bats will occasionally forage in groups of 20-30 individuals (DeGraaf and Yamasaki 2001) and typically emerge 1-2 hours after sunset, though they may forage throughout the night (Kunz 1973). The eastern red bat sequences were recorded at two tree detectors (Radar Tree and South Tree) and at three met detectors (Radar Met low, North Met Low, South Met). Eastern red bats tend to use forested habitat adjacent to streams and open fields (Shump and Shump 1982).

The BBSHHB guild includes the big brown bat, silver-haired bat, and hoary bat. Within this grouping, the hoary bat has easily distinguishable calls characterized by highly variable minimum frequencies often extending below 20 kHz, and a hooked profile similar to the eastern red bat. Calls of silver-haired bats and big brown bats are occasionally distinguishable, but often overlap in range and difficult to distinguish, especially when comparing short duration calls typical of those recorded during passive monitoring. In the spring, a single call sequence was classified as BBSHHB; the sequence was likely a big brown bat or silver-haired bat but was not diagnostic of either species. In the summer, 25 call sequences were classified as BBSHHB; thirteen of which were likely a big brown bat or silver-haired bat but were not diagnostic of either species. There were three call sequences identified as big-brown bat, four sequences identified as silver-haired bat, and six sequences identified as hoary bat. Both big brown and silver-haired bats forage in forested habitats (Kunz 1982, Kurta and Baker 1990).

Of all call sequences recorded at Oakfield in both seasons, 32 percent were classified as UNKN, due to their short duration or poor quality. However, these calls were identified as “high frequency” or “low frequency”. For the purposes of this analysis, “high frequency” call fragments were defined as having a minimum frequency above 30 kHz, and “low frequency” calls were defined as having a minimum frequency below 30 kHz. Nearly all call sequences classified as UNKN were high frequency (97 percent). Many of the high frequency unknown calls at the Radar Tree detector were likely *Myotis* species.

Differences in detection rates between guilds at the various detectors deployed in the Project area may reflect varying vertical distribution and habitat preferences of bat species (Hayes 2000). Recent research (Arnett 2006) found that small *Myotis* species were more frequently recorded at lower heights, while larger species were typically recorded more often at higher heights. This is generally consistent with observations at Oakfield during both spring and summer 2008.

Ongoing mortality studies and acoustic surveys indicate bat activity patterns during migration are responsive to weather conditions. Acoustic surveys have documented a decrease in bat activity rates as wind speed increases and temperatures decrease, and bat activity has been shown to correlate negatively with low nightly mean temperatures (Hayes 1997, Reynolds 2006). Similarly, weather factors appeared related to bat collision mortality rates documented at two facilities in the southeastern United States, with mortality rates negatively correlated with both wind speed and relative humidity, and positively correlated to barometric pressure (Arnett 2005). These patterns suggest that bats are more likely to migrate on nights with low wind speeds (less than 4-6 m/s) and generally favorable weather (warm temperatures, low humidity, high barometric pressure). At Oakfield, bat activity did not correlate strongly with weather conditions. This may be a function of the higher number of tree detectors, which are within the canopy and therefore more sheltered, relative to the met tower detectors.

Bat activity also appeared to vary by time of night. In the spring, a peak in activity occurred soon after dusk and a small peak occurring before dawn. The pre-dawn peak is mainly accounted for by activity at the South Tree detector, however. In the summer, peaks varied by detector but were typically between 11:00 pm and 2:00 am. Patterns of bat activity within nights can vary, and anywhere from one to several peaks of activity have been documented. This bimodal nighttime distribution of bat activity seems to be a consistent behavioral trend in a number of species (Hayes 1997). Anthony *et al*. (1981) documented that bats appear to leave roosting sites at dusk to forage for a given period, return to their roosts during the middle portion of the night, then forage again later in the evening, closer to dawn.

Results of acoustic surveys must be interpreted with caution. Considerable room for error exists in identification of bats based upon acoustic calls alone, especially if a site or regionally specific library of recorded reference calls is not available. Also, detection rates are not necessarily correlated with the actual numbers of bats in an area, because it is not possible to differentiate between individual bats (Hayes 2000). Stantec can provide a digital file of all acoustic calls, including all information about species identification and timing of calls from each detector on an hourly and nightly basis, should that information be desired.

## 3.5 CONCLUSIONS

Detector surveys conducted during the spring and summer 2008 migration period have provided information on bat activity in the vicinity of the Project area. Survey locations were representative of habitats in the Project area and included detectors at heights near the rotor zone. The surveys documented species that would be expected in the area based on the species' range and abundance, as well as the habitat types present in the Project area.

Bat activity during spring and summer at Oakfield during was similar to other ongoing regional studies. Although the levels of bat activity were variable throughout the spring and summer sampling period at each of the nine acoustic sampling locations, the species composition was consistent between detectors, with *Myotids* comprising the majority of call sequences in both seasons.

# 4.0 Diurnal Raptor Surveys

## 4.1 INTRODUCTION

The Project is located in the Laurentian Plains and Hills ecoregion of the "Eastern Continental Hawk Flyway[6]," which extends from the Canadian Maritimes south to eastern Florida. Within this large area, raptors tend to concentrate along linear ridges, which create updrafts or "thermals" that raptors can use to fly long distances with minimal exertion. Glacial processes from the Laurentian ice shelf recession shaped the entire ecoregion, creating numerous lakes and wetland areas and carving out the gradual western slopes and steep eastern slopes of the Project area. The ridgeline on Sam Drew and Timoney Mountains are arranged in northeast to southwest linear fashion. Oakfield Hills is isolated from Sam Drew Mountain to the south by a saddle, but both share topographical similarities in the eastern and western slopes. The Project ranges in elevations from approximately 393 m (1290') at the Peak of Sam Drew Mountain to approximately 162 m (530') at the East Branch of the Mattawamkeag River (Figure 1-1).

Stantec designed and conducted diurnal raptor surveys to identify potential popular migration corridors and document species specific flight and behavioral patterns near the Project area in accordance with recent and on-going seasonal raptor studies approved by U.S. Fish and Wildlife Service (USFWS) and Maine Department of Inland Fisheries and Wildlife (MDIFW).

## 4.2 METHODS

### 4.2.1 Field Surveys

Raptor surveys were conducted from the radar tower next to the met tower at the summit of Sam Drew Mountain (Figure 1-1). The radar tower afforded views to the south, east and west. Views down into the valley to the northwest were obstructed due to the nature of the gradually sloping terrain and vegetation. However, the observer was able to see over the tops of surrounding trees to account for raptors flying at eye level or higher over the northwestern valley.

Raptor surveys were conducted for twelve days from late April to late May and were generally performed on days with favorable flight conditions, which typically occur on days following the passage of weather fronts and low-pressure systems causing westerly winds. Surveys were based on Hawk Migration Association of North America (HMANA) methods (HMANA 2007). Surveys were conducted from 9 am to 4 pm, during the peak hours of thermal development and

[6] The Eastern Continental Flyway includes the Maritime Provinces; New England; New York (south and east of a line from Jamestown to Utica to the north end of Lake Champlain); Pennsylvania (all except Erie County); Mid-Atlantic States through Georgia, West Virginia, Kentucky and Tennessee; Florida east of a line from Lake Seminole south to Apalachicola (Kellogg 2007).

raptor movement. During surveys, observers scanned the sky and surrounding landscape for raptors with binoculars and a spotting scope. Observations were recorded onto HMANA data sheets, which summarize the data by hour. Hourly weather observations, including wind speed and direction, temperature, percent cloud cover, and precipitation were recorded. Information regarding the raptors' behavior and tendency to remain within the same location throughout the study period was noted in order to differentiate between migrating and resident birds. When possible, the general flight paths of observed individuals were plotted on topographic maps of the Project area.

Flight heights of birds were documented and categorized as less than, greater than, or equal to 120 m (394') above ground level (ground directly below the bird itself), which is the approximate height of the proposed wind turbines. Nearby objects with known heights, such as meteorological towers and nearby trees were used to gauge flight height.

Flight positions were categorized into 4 categories: A) flight path directly over Sam Drew (A1-parallel, or A2-perpendicular to Sam Drew, or A3-within valley saddle between Sam Drew and Oakfield Hills), B) flight path over upper slope portions of Sam Drew, C) flight path over lower slope of Sam Drew, and D) flight path not within Project area; Figure 4-1).

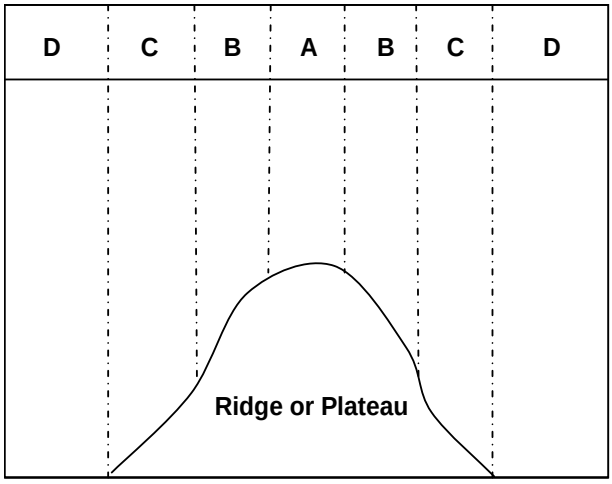


**Figure 4-1**. Flight position codes

Birds that flew too rapidly or were too far to accurately identify were recorded as unidentified to their genus or, if the identification of genus was not possible, unidentified raptor. Priority was given to raptor observations; however observers collected incidental data for other avian species observed including passerines and water birds.

### 4.2.2 Data Analysis

The raptor observation data was summarized by survey day and for the entire survey period. Analysis included a summary of:

- The total number of individuals per species observed for each survey day and for the entire survey period,
- The seasonal and daily observation rate (birds per hour). This was calculated for each survey day as well as for the entire spring survey period.
- The total number of individuals, by species, observed flying above or below 120 m (394') within the Project area; and
- The number of birds suspected to be resident based on their indirect flight paths and their tendency to occur in the Project area multiple times throughout the day.

The mapped flight paths and recorded flight positions were reviewed to identify any general flight patterns for migrant raptors in the vicinity of the Project area. In addition, minimum flight heights for individuals passing through each positional category were averaged.

Observations from the Project area were compared to 2008 data from local or regional HMANA hawk watch sites available on the HMANA web site or from HMANA yearly reports. Those HMANA watch sites used for comparison are from Bradbury Mountain in Maine, Barre Falls in Massachusetts, Shatterack Mountain in Massachusetts, Hawk Mountain in Pennsylvania and Allegheny Front in Pennsylvania. Although migration is likely to vary with topography, location, season, and weather, all HMANA sites used for comparison are within the Eastern Continental Hawk Flyway region. Also provided for comparison, are the results of available regional surveys conducted at other proposed wind farms mainly located in New York, Vermont, New Hampshire, and Maine.

## 4.3 RESULTS

Most surveys were conducted on clear days allowing for optimal visibility. Surveys were conducted from April 25 to May 30, resulting in a total of 12 survey days. Temperatures ranged from 3.3 to 25°C for the season. Winds speeds for the season ranged from calm (on April 20 and May 14) to 19.2 kilometers per hour (April 2). Observers detected 29 of 58 raptors on days with westerly winds, likely due to the updrafts created when wind collides with the western slope of Sam Drew Mountain. Raptors were observed 42 times between 9:00 am to 3:00 pm, an optimal time of day for thermals as the sun rises higher warming the earth's surface and mixing with nighttime air.

Surveys were conducted for a total of 79 hours during the 12 survey days. A total of 58 raptors representing 7 species was observed during that time (Figure 4-2), yielding an overall observation rate of 0.73 birds/hour. Daily count totals ranged from to 1 raptor on May 23 to 7 raptors on May 9, May 13 and May 14 (Figure 4-3; Appendix C, Table 1).

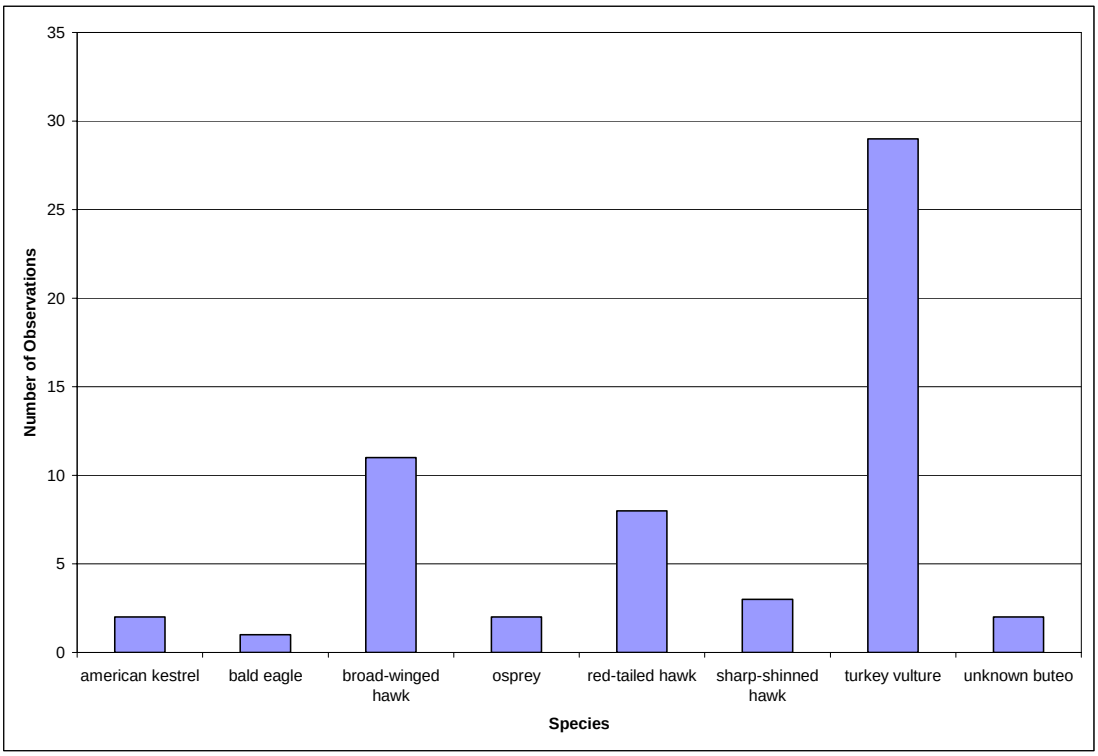


**Figure 4-2.** Species composition of raptors observed

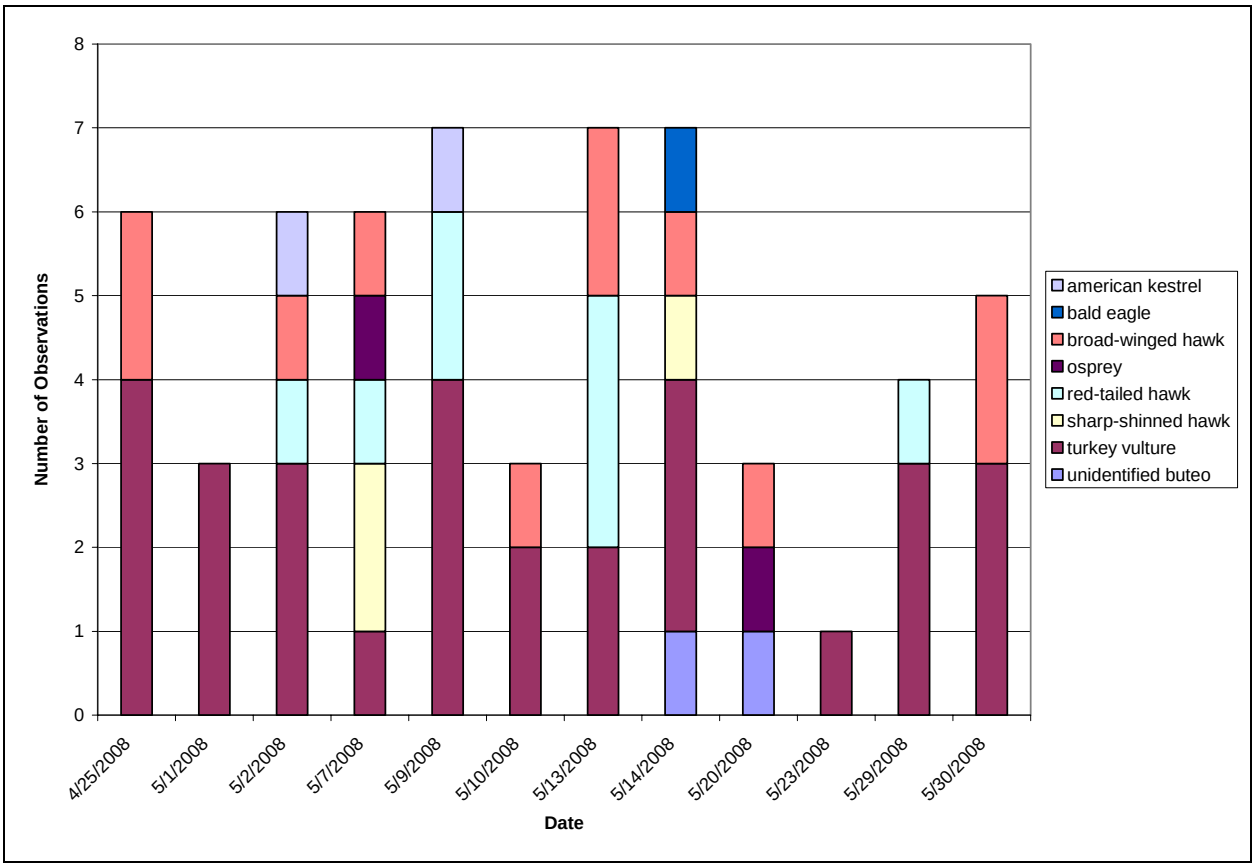


**Figure 4-3.** Daily species composition of raptors observed

Of the seven species observed flying over the Project area, a lone Bald eagle *(Haliaeetus leucocephalus)* was the only species observed that is state threatened in Maine. No other state of federally listed endangered or threatened species were observed.

In addition to varying ranges in daily counts due to seasonal variations, the timing of raptor observations varied during each survey day. The peak number of observations occurred between 11:00 am and 14:00 pm (Figure 4-4, Appendix C, Table 2). Observations made prior to 9:00 am were either resident or migrants utilizing stop over habitat near the Project area. This trend was generally consistent throughout the season, and likely mirrors patterns of thermal development above the ridgeline.

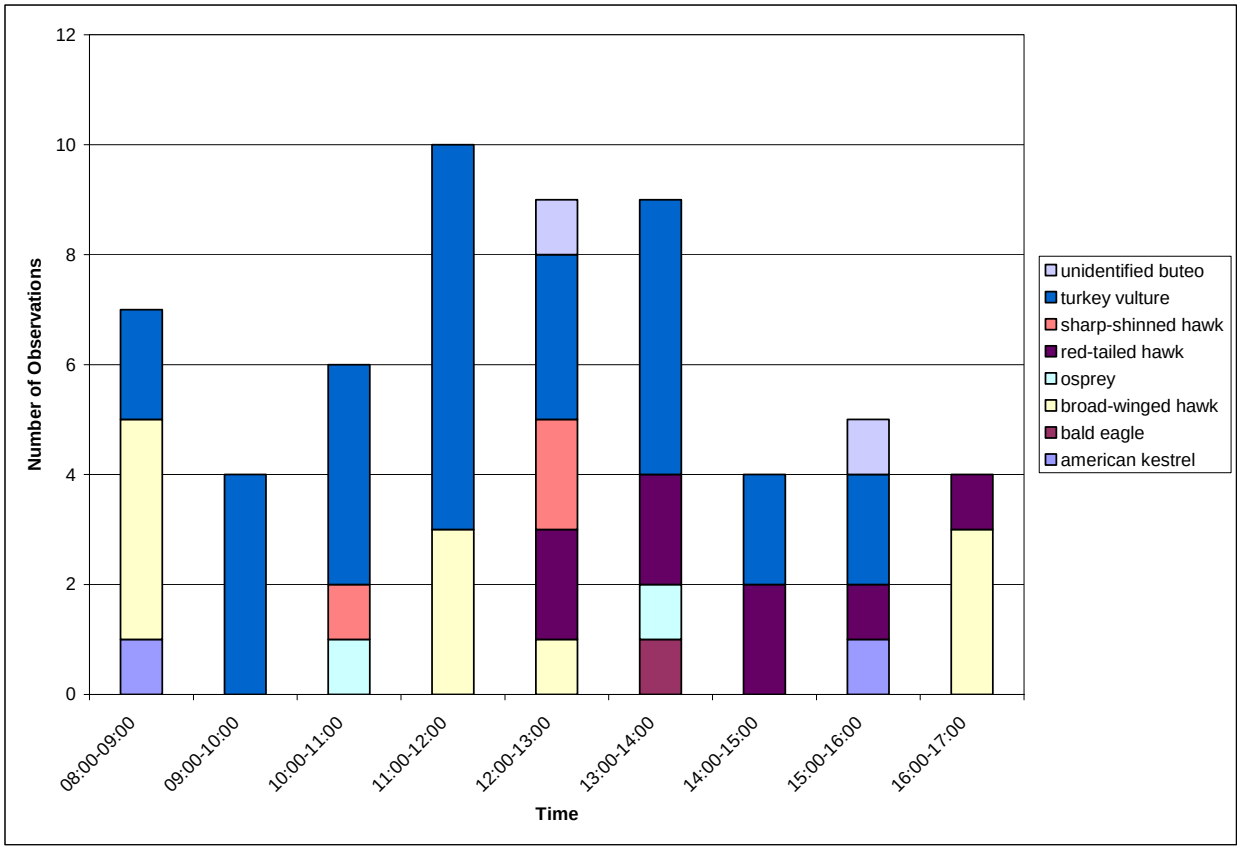


**Figure 4-4.** Hourly observation rates

As raptors traveled through or in the vicinity of the Project area, they often occurred in multiple flight positions (A-D) along the ridge or outside of the Project area[7]. Of the 77 recorded flight positions, forty percent (n=23) were observed flying directly over Sam Drew during some portion of their flight path (position A). Another forty percent (n=23) were observed flying along the upper slope or crest of the ridgeline (position B). Twenty-two percent (n=17) were observed flying along the lower slope (position C), and 18 percent (n=14) raptors were observed flying outside the Project area (position D). Of the 23 raptors flying directly above the ridgeline, 4 (17%) were observed flying along (or parallel to) the north/south linear ridgeline and 6 (20%) were observed flying perpendicularly over the ridgeline. No raptors were observed flying over the saddle between Sam Drew Mountain and Oakfield Hills.

For those birds observed flying within 1km of the observation, flight heights were categorized as below or above 120 m (394'), the approximate maximum height of the proposed turbines. Seventy-six percent of those raptors observed were flying less than 120 m above the ground for at least a portion of their flight through the Project area (Figure 4-5; Appendix C, Table 3);

[7] The result of which is a higher number of recorded flight positions (n=77) than individual bird observations (n=58).

however, only 32 percent (n=16) of raptor positions observed within 1 km were flying directly over the ridge (position A) at a flight under 120 m.

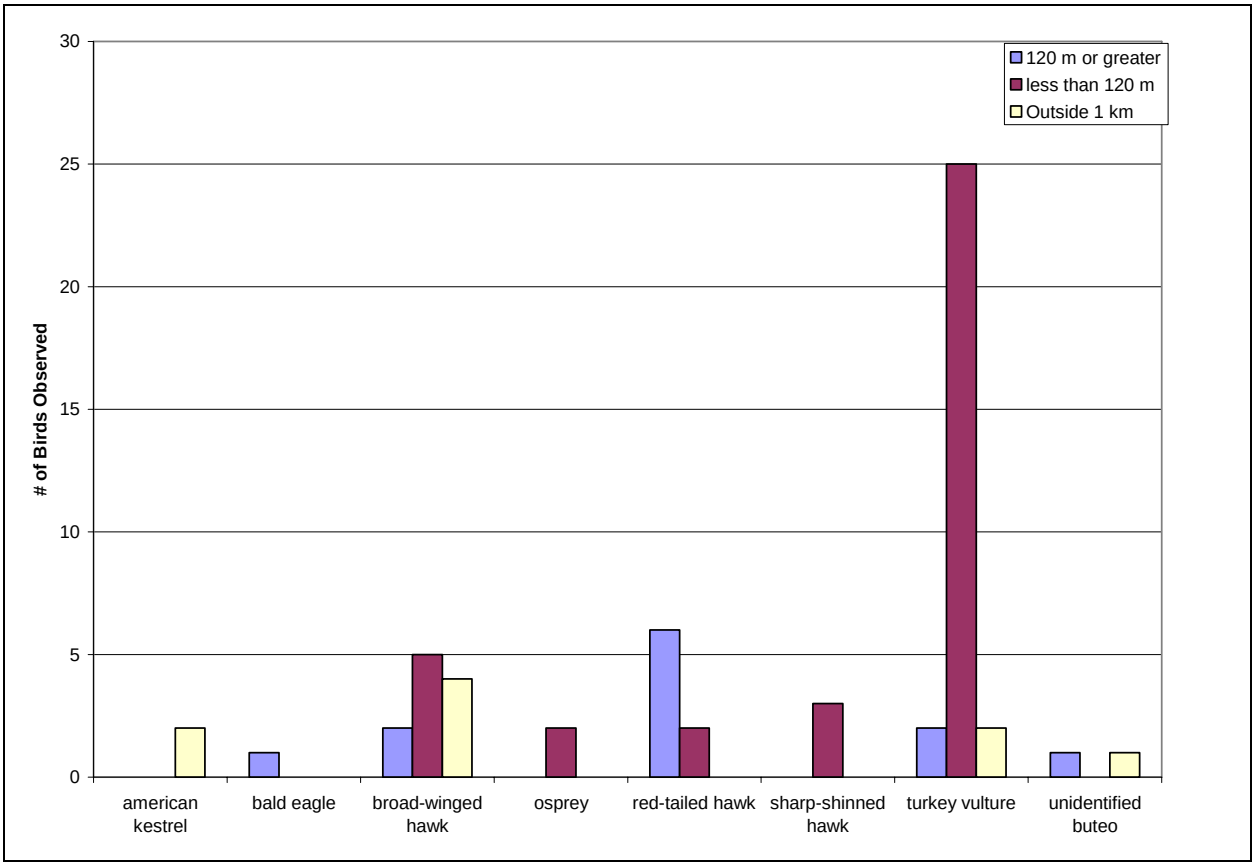


**Figure 4-5.** Raptor flight height distribution

The average of the minimum recorded flight height was calculated for observations of birds within each flight category: for the 23 observations in position A, the average minimum flight height was 90 m (295'); for the 23 birds in position B, the average minimum flight height was 54 m (178'); for the 17 birds in position C, the average minimum flight height was 107 m (351'); and for the 5 birds seen in position D, the average minimum flight height was 226 m (741').

## 4.4 DISCUSSION

A total of 58 raptors were observed during the 12 survey days during April 25 to May 30. A total of 9 species were recorded with an overall observation rate of 0.73 birds per hour. Turkey vultures were the most abundant species observed and comprised approximately 50 percent of all observations. Initial detection of a Bald eagle was over Meduxnekeag Lake on May 14. It was observed soaring high (350-400 m) and moving to the south over the valley and then along the slope of Hunt Ridge. There was one confirmed nest at Mednuxnekeag Lake as of 2006 and there are two other Bald eagle nests within 6.5 miles of the Oakfield Wind Project.

During the spring migration season, daily raptor counts at other sites in the region ranged from approximately 12 to 1320 individuals. The most active site during those 12 days was Bradbury Mountain in Maine. Passage rates at nearby sites were 8.4 raptors per observer hour at Bradbury Mountain in Maine. Barre Falls, Massacusetts had a seasonal passage rate of 6.1 raptors/observer hour and at Shatterack Mountain, Massachusetts there were 3.5 raptors/observation hour. The overall seasonal passage rate at Oakfield was 0.73 raptors per observation hour (Appendix C, Table 4). Hawkwatch sites that are located at prominent topographical points, such as Hawk Mountain, PA and Allegheny Front, are along popular migratory routes consisting of long ridgelines with generally north to south orientations, and, therefore, serve as leading lines for migrants. Organized hawk count locations typically target areas of known concentrated raptor migration activity. Therefore, publicly available results of past spring surveys done at other wind sites in the region are included (Appendix C, Table 5).

The Stetson Mountain seasonal passage rate was comparable to that at Oakfield. Both sites are topographically similar with numerous Laurentian hills, wetlands and drainages across the landscape. Mars Hill topography is somewhat similar in that both share linear ridgelines but the landscape surrounding Mars Hill show elevation changes to be more gradual than at Sam Drew Mountain. Other publicly available data from wind sites in New England are Deerfield, VT and Lempster, NH and show higher seasonal passage rates than Oakfield.

There are several reasons for the variations in raptors observed among hawk watch sites in spring, including survey effort, geographical location, and visibility. Geographical location can affect the magnitude of raptor migration at a particular site. Survey efforts vary from site to site. Organized hawk watch locations are usually surveyed when the weather is optimal for raptor migration and typically during the peak of the migration season. There are, of course, various peak migration periods for different species, as well variations among juvenile and adult birds of the same species.

The flight heights of raptors observed in the Project area indicate that migrating raptors occur in the zone of the blade-swept area of the proposed turbines. Of the total number of individual raptors observed, 76 percent were observed below 120 m (394') for at least a portion of their flight through the Project area; however, only 32 percent were observed directly over Sam Drew Mountain.

Flight height of raptors varied by survey day, individual raptor, and species. Variations in the flight heights of raptors are due to the particular flight behaviors of raptor species, as well as daily weather conditions. Typically, accipiters and falcons use up-drafts from side slopes to gain lift and, therefore, fly low over ridgelines. Buteos tend to use lift from thermals that develop over side slopes and valleys and tend to fly high during hours of peak thermal development. Raptors typically fly lower than usual during windy or inclement conditions. Typically, accipiters and falcons use up-drafts from side slopes to gain lift and, therefore, fly low over ridgelines.

Flight patterns showed that Sam Drew Mountain serves as a leading line as a majority of raptors (80 percent) utilized updrafts and thermals above the ridgeline and upper slopes or crest of the

ridgeline. Flight patterns revealed no preference between flying parallel or perpendicular to the ridgeline. No observations were made of raptors flying over the saddle between Sam Drew Mountain and Oakfield Hills.

Migration of raptors is a dynamic process due to various behavioral and environmental factors. As a result, flight pathways and movements along ridges, side slopes, and across valleys may vary seasonally, daily, or hourly. Raptors may shift and use different ridge lines and cross different valleys from year to year or season to season. Weather and wind are major factors that influence migration pathways. The flight paths of raptors observed in the Project area varied between survey dates and were influenced by varying wind direction and weather. Wind strongly affects the propensity of raptors to concentrate along linear features (such as rivers and ridges). The precise location of the migrants relative to a linear feature is what directs concentrations of migrating birds along linear features and can be related to lateral drift caused by crosswinds (Richardson 1998).

Peer reviewed research and first hand observations that detail flight behavior of raptors through wind sites show that raptors use the updrafts and thermals created along leading lines during migration and foraging (Barrios & Rodriguez, 2004; Hoover & Morrison, 2005). Both behaviors are known to increase collision risk. However, peer reviewed studies have also documented high raptor collision avoidance behaviors at modern wind facilities (Whitfield and Madders 2006, Chamberlain *et al.* 2006). The mechanism of raptor turbine avoidance is unknown; however, as most raptors are diurnal, raptors may be able to visually, as well as acoustically detect turbines. Unpublished observations of hawk migration activity at an existing wind facility in New England indicate raptors have been observed rising above operating turbines and then decreasing altitude between turbines. It is unclear if this type of presumed avoidance behavior would be characteristic of raptors in general, and could therefore be expected at other wind turbine facilities in the East. It is also common for mortality studies to incorporate correctional factors, such as searcher efficiency and scavenging rates, to adjust previous fatality numbers into mortality estimates (Smallwood and Thelander 2008).

Although the greater occurrence of migrants at low altitudes increases the potential for migrating raptors to come into the vicinity of the proposed wind turbines, raptor mortality in the United States, outside of California, has been documented to be very low. For example, mortality rates found at onshore wind developments, outside of Altamont Pass in California, have documented 0 to 0.07 fatalities/turbine/year from 2000-2004 (GAO 2005). A more recent study at the Maple Ridge Wind Power facility in New York also documented very low raptor mortality. Only a single American kestrel was found, in a one year study covering 50 of 120 operational turbine sites (Jain *et al* 2007). Additionally, several other studies conducted recently in the U.S have documented few raptor fatalities and scarcely more than 15 fatalities have been reported at more than a dozen sites surveyed. During on-going, year-long, post-construction surveys at the Mars Hill Wind farm, Stantec has to-date not encountered any hawk or eagle carcasses, despite relatively similar habitat use and pre-construction data documenting the presence of eagles (Stantec unpublished data).

## 4.5 CONCLUSIONS

Raptor passage rates observed at different sites in the region vary due to topography, location, season, weather, and visibility. The spring 2008 passage rate at Oakfield is low in comparison to other HMANA sites in the region during the same timeframe, and is similar to passage rates observed at other proposed wind farms in the region where visibility and topography are generally comparable.

Although 76 percent of observed flights in the Project area occurred below the maximum rotor-zone of the proposed turbines, only 32 percent were observed flying directly over Sam Drew Mountain. Despite the generally low observed flight heights of raptors (generally 9 to 89 percent of migrants occur below the rotor-zone at proposed wind farms in the region), raptors have demonstrated high turbine collision avoidance behaviors as well as relatively low collision mortality at existing wind farms.

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_____. 2006g. A Spring 2006 Radar, Visual, and Acoustic Survey of Bird Migration at the Mars Hill Wind Farm in Mars Hill, Maine. Prepared for Evergreen Windpower, LLC.

_____. 2007a. A Spring 2007 Survey of Bird and Bat Migration at the Proposed Stetson Mountain Wind Power Project in Washington County, Maine. Prepared for Evergreen Wind V, LLC.

# Appendix A

Radar Survey Results

**Appendix A Table 1. Survey dates, results, level of effort, and weather - Spring 2008**

| Date | Passage rate | Flight Direction | Flight Height (m) | % below 120 m | Hours of Survey | Temperature (c) | Wind Speed (m/s) | Wind Direction (from) |
|---|---|---|---|---|---|---|---|---|
| 5/1/08 | 132 | 142.765° | 143 | 62% | 9 | -1.3 | 8.5 | 328.1 |
| 5/2/08 | 399 | 346.751° | 519 | 12% | 9 | 2.4 | 6.2 | 104.4 |
| 5/3/08 | 775 | 38.63° | 265 | 20% | 9 | 4.6 | 7.3 | 182.0 |
| 5/7/08 | 610 | 58.313° | 441 | 13% | 8 | 9.1 | 6.0 | 205.2 |
| 5/9/08 | 660 | 279.652° | 231 | 37% | 9 | 5.3 | 8.4 | 66.8 |
| 5/11/08 | 393 | 311.514° | 169 | 36% | 9 | 4.2 | 8.0 | 72.5 |
| 5/12/08 | 606 | 326.716° | 180 | 34% | 9 | 6.8 | 6.9 | 52.7 |
| 5/13/08 | 455 | 12.949° | 263 | 32% | 9 | 8.6 | 5.7 | 77.0 |
| 5/14/08 | 789 | 358.851° | 421 | 20% | 9 | 9.4 | 7.5 | 127.0 |
| 5/19/08 | 341 | 74.894° | 111 | 61% | 6 | 4.7 | 9.1 | 268.7 |
| 5/20/08 | 607 | 43.495° | 294 | 22% | 9 | 8.4 | 2.4 | 131.3 |
| 5/21/08 | 682 | 39.033° | 401 | 13% | 9 | 7.3 | 3.9 | 194.9 |
| 5/26/08 | 899 | 32.079° | 350 | 9% | 8 | 10.5 | 8.8 | 197.6 |
| 5/27/08 | 261 | 101.068° | 169 | 45% | 8 | 3.7 | 10.5 | 312.2 |
| 5/28/08 | 654 | 53.188° | 141 | 57% | 9 | 8.1 | 9.9 | 255.5 |
| 5/29/08 | 189 | 133.151° | 189 | 52% | 9 | 5.5 | 8.8 | 322.6 |
| 5/30/08 | 573 | 45.868° | 303 | 24% | 9 | 10.0 | 7.6 | 223.8 |
| 6/1/08 | 273 | 178.876° | 390 | 17% | 9 | 8.0 | 7.9 | 342.6 |
| 6/2/08 | 409 | 57.311° | 350 | 16% | 9 | 11.1 | 6.9 | 268.8 |
| 6/3/08 | 254 | 80.569° | 187 | 36% | 9 | 11.1 | 4.1 | 307.8 |

**Appendix A Table 2. Summary of passage rates by hour, night, and for entire season.**

| Night of | Passage Rate (targets/km/hr) by hour after sunset | | | | | | | | | Entire Night | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **Mean** | **Stdev** | **SE** |
| 5/1/08 | 330 | 336 | 96 | 121 | 93 | 38 | 43 | 57 | 75 | 132 | 117 | 39 |
| 5/2/08 | 311 | 425 | 229 | 340 | 369 | 474 | 584 | 463 | 393 | 399 | 104 | 35 |
| 5/3/08 | 1213 | 1406 | 1221 | 1196 | 825 | 497 | 367 | 204 | 43 | 775 | 509 | 170 |
| 5/7/08 | 307 | 518 | 498 | 511 | 732 | 766 | 830 | 718 | -- | 610 | 178 | 63 |
| 5/9/08 | 193 | 1046 | 1050 | 1110 | 1101 | 721 | 407 | 182 | 129 | 660 | 432 | 144 |
| 5/11/08 | 386 | 806 | 995 | 807 | 296 | 96 | 99 | 27 | 21 | 393 | 381 | 127 |
| 5/12/08 | 686 | 1200 | 861 | 664 | 557 | 543 | 346 | 429 | 164 | 606 | 302 | 101 |
| 5/13/08 | 150 | 450 | 407 | 454 | 536 | 718 | 536 | 471 | 377 | 455 | 152 | 51 |
| 5/14/08 | 450 | 817 | 836 | 846 | 711 | 754 | 879 | 1496 | 307 | 789 | 330 | 110 |
| 5/19/08 | 688 | 514 | 336 | 371 | 120 | 14 | -- | -- | -- | 341 | 248 | 101 |
| 5/20/08 | 369 | 845 | 627 | 809 | 964 | 825 | 625 | 364 | 39 | 607 | 298 | 99 |
| 5/21/08 | 424 | 846 | 943 | 392 | 484 | 539 | 932 | 1414 | 161 | 682 | 383 | 128 |
| 5/26/08 | -- | 861 | 677 | 846 | 1452 | 939 | 991 | 797 | 630 | 899 | 254 | 90 |
| 5/27/08 | 161 | 805 | 326 | 248 | 236 | 178 | 46 | 86 | -- | 261 | 238 | 84 |
| 5/28/08 | 357 | 1024 | 914 | 932 | 857 | 632 | 543 | 446 | 179 | 654 | 294 | 98 |
| 5/29/08 | 152 | 298 | 240 | 279 | 193 | 225 | 182 | 133 | 0 | 189 | 89 | 30 |
| 5/30/08 | 129 | 1029 | 1075 | 621 | 734 | 677 | 407 | 419 | 64 | 573 | 355 | 118 |
| 6/1/08 | 439 | 763 | 437 | 250 | 193 | 136 | 159 | 75 | 7 | 273 | 235 | 78 |
| 6/2/08 | 143 | 636 | 514 | 450 | 443 | 536 | 551 | 391 | 21 | 409 | 201 | 67 |
| 6/3/08 | 204 | 632 | 434 | 199 | 114 | 150 | 220 | 182 | 150 | 254 | 169 | 56 |
| **Entire Season** | 373 | 763 | 636 | 572 | 551 | 473 | 460 | 440 | 162 | **498** | **218** | **49** |

| Appendix A Table 3. Mean Nightly Flight Direction | | |
|---|---|---|
| **Night of** | **Mean Flight Direction** | **Circular Stdev** |
| 5/1/08 | 142.765° | 46.778° |
| 5/2/08 | 346.751° | 60.811° |
| 5/3/08 | 38.63° | 30.834° |
| 5/7/08 | 58.313° | 62.383° |
| 5/9/08 | 279.652° | 50.008° |
| 5/11/08 | 311.514° | 39.223° |
| 5/12/08 | 326.716° | 77.334° |
| 5/13/08 | 12.949° | 60.501° |
| 5/14/08 | 358.851° | 35.479° |
| 5/19/08 | 74.894° | 33.386° |
| 5/20/08 | 43.495° | 46.247° |
| 5/21/08 | 39.033° | 41.729° |
| 5/26/08 | 32.079° | 30.111° |
| 5/27/08 | 101.068° | 45.292° |
| 5/28/08 | 53.188° | 24.314° |
| 5/29/08 | 133.151° | 68.729° |
| 5/30/08 | 45.868° | 22.742° |
| 6/1/08 | 178.876° | 61.131° |
| 6/2/08 | 57.311° | 28.265° |
| 6/3/08 | 80.569° | 67.999° |
| **Entire Season** | 33.478° | 65.445° |

**Appendix A Table 4. Summary of mean flight heights by hour, night, and for entire season.**

| Night of | Mean Flight Height (m) by hour after sunset | | | | | | | | | | Entire Night | | | % of targets below 120 meters |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Mean | STDV | SE | |
| 5/1/08 | -- | -- | 117 | 257 | 265 | 154 | 25 | 27 | 153 | -- | 143 | 97 | 37 | 62% |
| 5/2/08 | 249 | 645 | 660 | 597 | 582 | 615 | 493 | 494 | 340 | -- | 519 | 142 | 47 | 12% |
| 5/3/08 | 203 | 289 | 256 | 325 | 325 | 276 | 175 | 273 | -- | -- | 265 | 53 | 19 | 20% |
| 5/7/08 | 197 | 362 | 594 | 574 | 485 | -- | 479 | 397 | -- | -- | 441 | 137 | 52 | 13% |
| 5/9/08 | 124 | 181 | 262 | 255 | 253 | 282 | 281 | 266 | 295 | 107 | 231 | 68 | 22 | 37% |
| 5/11/08 | 176 | 250 | 238 | 262 | 267 | 106 | 128 | 59 | -- | 38 | 169 | 90 | 30 | 36% |
| 5/12/08 | 177 | 253 | 173 | 154 | 184 | 159 | 199 | 203 | 119 | -- | 180 | 37 | 12 | 34% |
| 5/13/08 | 181 | 349 | 440 | 360 | 397 | 160 | 205 | 173 | 105 | -- | 263 | 123 | 41 | 32% |
| 5/14/08 | 196 | 458 | 502 | 483 | 476 | 460 | 382 | 294 | 541 | -- | 421 | 111 | 37 | 20% |
| 5/19/08 | 142 | -- | 129 | 126 | 85 | 73 | -- | -- | -- | -- | 111 | 30 | 13 | 61% |
| 5/20/08 | 222 | 283 | 329 | 244 | 257 | 284 | 411 | 361 | 258 | -- | 294 | 61 | 20 | 22% |
| 5/21/08 | 279 | 371 | 307 | 424 | 456 | 498 | 542 | 402 | 335 | -- | 401 | 88 | 29 | 13% |
| 5/26/08 | -- | 419 | 346 | 320 | 425 | 426 | 316 | 272 | 272 | -- | 350 | 66 | 23 | 9% |
| 5/27/08 | 363 | 213 | 184 | 167 | 144 | 125 | 238 | 85 | 5.2 | -- | 169 | 101 | 34 | 45% |
| 5/28/08 | 140 | 174 | 134 | 163 | 140 | 127 | 111 | 131 | 150 | -- | 141 | 19 | 6 | 57% |
| 5/29/08 | 121 | 209 | 104 | 83 | 146 | 84 | 80 | 157 | 716 | -- | 189 | 202 | 67 | 52% |
| 5/30/08 | 242 | 318 | 240 | 224 | 239 | 350 | 297 | 355 | 460 | -- | 303 | 77 | 26 | 24% |
| 6/1/08 | 182 | 367 | 395 | 329 | 302 | 422 | 356 | 766 | -- | -- | 390 | 168 | 60 | 17% |
| 6/2/08 | 283 | 410 | 406 | 417 | 366 | 327 | 354 | 290 | 295 | -- | 350 | 54 | 18 | 16% |
| 6/3/08 | 165 | 261 | 241 | 161 | 146 | 172 | 172 | 130 | 237 | -- | 187 | 47 | 16 | 36% |
| **Entire Season** | 202 | 323 | 303 | 294 | 297 | 268 | 276 | 270 | 285 | 73 | **276** | **117** | **26** | **21%** |

-- indicates no data for that hour

**Appendix A Table 5. Bird and bat targets observed during radar and ceilometer surveys.**

| Night of | Radar Results | | | | Ceilometer Results | |
|---|---|---|---|---|---|---|
| | Possible Bird Targets | Possible Bat Targets | Likely Insects | # of Obs Periods | Birds | Bats |
| 5/1/08 | 100% | 0% | 0% | | | |
| 5/2/08 | 100% | 0% | 0% | | | |
| 5/3/08 | 100% | 0% | 0% | | | |
| 5/7/08 | 100% | 0% | 0% | | | |
| 5/9/08 | 100% | 0% | 0% | | | |
| 5/11/08 | 100% | 0% | 0% | | | |
| 5/12/08 | 98% | 2% | 0% | | | |
| 5/13/08 | 100% | 0% | 0% | | | |
| 5/14/08 | 100% | 0% | 0% | | | |
| 5/19/08 | 100% | 0% | 0% | 5 | 0 | 1 |
| 5/20/08 | 100% | 0% | 0% | 5 | 3 | 1 |
| 5/21/08 | 100% | 0% | 0% | 6 | 3 | 1 |
| 5/26/08 | 100% | 0% | 0% | 4 | 0 | 6 |
| 5/27/08 | 100% | 0% | 0% | 4 | 1 | 1 |
| 5/28/08 | 100% | 0% | 0% | 5 | 1 | 2 |
| 5/29/08 | 100% | 0% | 0% | 5 | 1 | 8 |
| 5/30/08 | 100% | 0% | 0% | 5 | 5 | 8 |
| 6/1/08 | 100% | 0% | 0% | 5 | 5 | 8 |
| 6/2/08 | 100% | 0% | 0% | 5 | 4 | 16 |
| 6/3/08 | 100% | 0% | 0% | 5 | 16 | 14 |
| **Total** | **100%** | **0%** | **0%** | **54** | **39** | **66** |

**Appendix A Table 6. Summary of available spring avian radar survey results**

| Project Site | No. of Survey Nights | No. of Survey Hours | Landscape | Average Passage Rate (t/km/hr) | Range in Nightly Passage Rates | Average Flight Direction | Average Flight Height (m) | (Turbine Ht) % Targets Below Turbine Height | Citation |
|---|---|---|---|---|---|---|---|---|---|
| **Spring 2003** | | | | | | | | | |
| Westfield Chautauqua Cty, NY | 30 | 150 | Great Lakes Shore | 395 | 15-1702 | 29 | 528 | (125 m) 4% | Cooper *et al.*2004 |
| **Spring 2005** | | | | | | | | | |
| Churubusco, Clinton Cty, NY | 39 | 310 | Great Lakes plain/ADK foothills | 254 | 3-728 | 40 | 422 | (120 m) 11% | Woodlot 2005a |
| Ellenberg, Clinton Cty, NY | n/a | n/a | Great Lakes plain/ADK foothills | 110 | n/a | 30 | 338 | (n/a) 20% | Mabee *et al.* 2006a |
| Dairy Hills, Clinton Cty, NY | n/a | n/a | Great Lakes shore | 117 | n/a | 14 | 397 | (n/a) 15% | ED&R 2006b |
| Clayton, Jefferson Cty, NY | 36 | 303 | Agricultural plateau | 450 | 71-1769 | 30 | 443 | (150 m) 14% | Woodlot 2005b |
| High Sheldon, Wyoming Cty, NY | 38 | 272 | Agricultural plateau | 112 | 6-558 | 25 | 418 | (120 m) 6% | Woodlot 2006a |
| Prattsburgh, Steuben Cty, NY | 20 | 183 | Agricultural plateau | 277 | 70-621 | 22 | 370 | (125 m) 16% | Woodlot 2005c |
| Prattsburgh, Steuben Cty, NY | 30 | 270 | Agricultural plateau | 170 | 3-844 | 18 | 319 | (125 m) 18% | Mabee *et al.* 2005a |
| Cohocton, Steuben Cty, NY | 3 | 29 | Agricultural plateau | 371 | 133-773 | 28 | 609 | (125 m) 12% | ED&R 2006a |
| Munnsville, Madison Cty, NY | 41 | 388 | Agricultural plateau | 160 | 6-1065 | 31 | 291 | (118 m) 25% | Woodlot 2005d |
| Fairfield, Herkimer Cty, NY | 40 | 369 | Agricultural plateau | 509 | 80-1175 | 44 | 419 | (125 m) 20% | Woodlot 2005e |
| Jordanville, Herkimer Cty, NY | 40 | 364 | Agricultural plateau | 409 | 26-1410 | 40 | 371 | (125 m) 21% | Woodlot 2005f |
| Sheffield, Caledonia Cty, VT | 20 | 179 | Forested ridge | 208 | 11-439 | 40 | 522 | (125 m) 6% | Woodlot 2006b |
| Deerfield, Bennington Cty, VT | 20 | 183 | Forested ridge | 404 | 74-973 | 69 | 523 | (125 m) 4% | Woodlot 2005g |
| Franklin, Pendleton Cty, WV | 23 | 204 | Forested ridge | 457 | 34-240 | 53 | 492 | (125 m) 11% | Woodlot 2005h |
| **Spring 2006** | | | | | | | | | |
| Chateaugay, Franklin Cty, NY | 35 | 300 | Agricultural plateau | 360 | 54-892 | 48 | 409 | (120 m) 18% | Woodlot 2006c |
| Wethersfield, Wyoming Cty, NY | 44 | n/a | Agricultural plateau | 324 | 41-907 | 12 | 355 | (125 m) 19% | Mabee et al. 2006b |
| Centerville, Allegany Cty, NY | 42 | n/a | Agricultural plateau | 290 | 25-1140 | 22 | 351 | (125 m) 16% | Mabee et al. 2006b |
| Howard, Steuben Cty, NY | 42 | 440 | Agricultural plateau | 440 | 35-2270 | 27 | 426 | (125 m) 13% | Woodlot 2006d |
| Deerfield, Bennington Cty, VT | 26 | 236 | Forested ridge | 263 | 5-934 | 58 | 435 | (100 m) 11% | Woodlot 2006e |
| Kibby, Franklin Cty, ME (Mtn) | 6 | 33 | Forested ridge | 456 | 88-1500 | 67 | 368 | (120 m) 14% | Woodlot 2006f |
| Kibby, Franklin Cty, ME (Range 1) | 10 | 80 | Forested ridge | 197 | 6-471 | 50 | 412 | (120 m) 22% | Woodlot 2006f |
| Kibby, Franklin Cty, ME (Range 2) | 7 | 57 | Forested ridge | 512 | 18-757 | 86 | 378 | (120 m) 25% | Woodlot 2006f |
| Kibby, Franklin Cty, ME (Valley) | 2 | 14 | Forested valley | 443 | 45-1242 | 61 | 334 | (120 m) n/a | Woodlot 2006f |
| Mars Hill, Aroostook Cty, ME | 15 | 85 | Forested ridge | 338 | 76-674 | 58 | 384 | (120 m) 14% | Woodlot 2006g |
| **Spring 2007** | | | | | | | | | |
| Stetson, Washington Cty, ME | 21 | 138 | Forested ridge | 147 | 3 – 434 | 55 | 210 | (120 m) 22% | Stantec 2007a |
| Lempster, Sullivan Cty, NH | 30 | 277 | Forested ridge | 542 | 49-1094 | 49 | 358 | (125 m) 18% | Woodlot 2007c |
| Coos Cty, NH | 30 | 212 | Forested ridge | 342 | 2 - 870 | 76 | 332 | (125 m) 14% | Stantec Consulting 2007a |
| **Spring 2008** | | | | | | | | | |
| Rollins, Penobscot Cty, ME | 20 | 189 | Forested ridge | 247 | 40 - 766 | 75 | 316 | (120 m) 13% | Stantec 2008a |

# Appendix B

Bat Survey Results

**Appendix B Table 1**. Summary of acoustic bat data and weather during each survey night at the Radar Met High detector – Spring 2008

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Night of** | **Operated Okay?** | **big brown bat** | **hoary bat** | **silver-haired bat** | **silver-haired/big brown** | **eastern pipistrelle** | **eastern red bat** | **pipistrelle/red bat** | **MYSP** | **high-frequency** | **low-frequency** | **unknown** | **Total** | **Wind Speed (m/s)** | **Wind Direction (degrees)** | **Relative Humidity (%)** | **Temperature (celsius)** |
| 4/25/08 | Yes | | | | | | | | | | | | **0** | 6.5 | 84.6 | 69.5 | 2.3 |
| 4/26/08 | Yes | | | | | | | | | | | | **0** | 7.7 | 112.0 | 70.2 | 2.7 |
| 4/27/08 | Yes | | | | | | | | | | | | **0** | 4.8 | 168.3 | 68.3 | 3.8 |
| 4/28/08 | Yes | | | | | | | | | | | | **0** | 11.3 | 145.4 | 71.4 | 5.0 |
| 4/29/08 | Yes | | | | | | | | | | | | **0** | 11.0 | 159.0 | 64.9 | 2.5 |
| 4/30/08 | Yes | | | | | | | | | | | | **0** | 8.2 | 324.0 | 62.8 | -2.3 |
| 5/1/08 | Yes | | | | | | | | | | | | **0** | 8.5 | 328.1 | 55.1 | -1.3 |
| 5/2/08 | Yes | | | | | | | | | | | | **0** | 6.2 | 104.4 | 66.0 | 2.4 |
| 5/3/08 | Yes | | | | | | | | | | | | **0** | 7.3 | 182.0 | 58.6 | 4.6 |
| 5/4/08 | Yes | | | | | | | | | | | | **0** | 4.9 | 212.2 | 80.1 | 2.8 |
| 5/5/08 | Yes | | | | | | | | | | | | **0** | 2.6 | 306.9 | 73.9 | 9.1 |
| 5/6/08 | Yes | | | | | | | | | | | | **0** | 5.6 | 292.4 | 50.3 | 11.4 |
| 5/7/08 | Yes | | | | | | | | | | | | **0** | 6.0 | 205.2 | 42.5 | 9.1 |
| 5/8/08 | Yes | | | | | | | | | | | 2 | **2** | 11.0 | 306.1 | 87.3 | 5.0 |
| 5/9/08 | Yes | | | | | | | | | | | | **0** | 8.4 | 66.8 | 75.8 | 5.3 |
| 5/10/08 | Yes | | | | | | | | | | | | **0** | 9.1 | 26.8 | 85.6 | 2.7 |
| 5/11/08 | Yes | | | | | | | | | | | | **0** | 8.0 | 72.5 | 74.1 | 4.2 |
| 5/12/08 | Yes | | | | | | | | | | | | **0** | 6.9 | 52.7 | 60.9 | 6.8 |
| 5/13/08 | Yes | | | | | | | | | | | | **0** | 5.7 | 77.0 | 56.5 | 8.6 |
| 5/14/08 | Yes | | | | | | | | | | | | **0** | 7.5 | 127.0 | 50.7 | 9.4 |
| 5/15/08 | Yes | | | | | | | | | | | | **0** | 9.5 | 319.6 | 77.5 | 9.6 |
| 5/16/08 | Yes | | | | | | | | | | | 1 | **1** | 7.2 | 48.1 | 53.8 | 10.2 |
| 5/17/08 | Yes | | | | | | | | | | | | **0** | 7.9 | 236.7 | 77.8 | 8.3 |
| 5/18/08 | Yes | | | | | | | | | | | | **0** | 7.1 | 178.4 | 66.0 | 9.8 |
| 5/19/08 | Yes | | | | | | | | | | | | **0** | 9.1 | 268.7 | 95.8 | 4.7 |
| 5/20/08 | Yes | | | | | | | | | | | | **0** | 2.4 | 131.3 | 72.2 | 8.4 |
| 5/21/08 | Yes | | | | | | | | | | | | **0** | 3.9 | 194.9 | 95.5 | 7.3 |
| 5/22/08 | Yes | | | | | | | | | | | | **0** | 8.5 | 329.1 | 96.0 | 6.2 |
| 5/23/08 | Yes | | | | | | | | | | | | **0** | 8.0 | 332.7 | 85.8 | 4.5 |
| 5/24/08 | Yes | | | | | | | | | | | | **0** | 8.1 | 333.9 | 58.2 | 8.4 |
| 5/25/08 | Yes | | | | | | | | | | | | **0** | 9.5 | 247.8 | 49.3 | 12.8 |
| 5/26/08 | Yes | | | | | | | | | | | | **0** | 8.8 | 197.6 | 91.8 | 10.5 |
| 5/27/08 | Yes | | | | | | | | | | | | **0** | 10.5 | 312.2 | 70.3 | 3.7 |
| 5/28/08 | Yes | | | | | | | | | | | | **0** | 9.9 | 255.5 | 54.8 | 8.1 |
| 5/29/08 | Yes | | | | | | | | | | | | **0** | 8.8 | 322.6 | 55.7 | 5.5 |
| 5/30/08 | Yes | | | | | | | | | | | | **0** | 7.6 | 223.8 | 59.5 | 10.0 |
| 5/31/08 | Yes | | | | | | | | | | | | **0** | 6.6 | 213.3 | 98.3 | 9.6 |
| **By Species** | | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **3** | **3** | | | | |
| **By Guild** | | **0** | | | | **0** | | | **0** | **3** | | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | | |

**Appendix B Table 2.** Summary of acoustic bat data and weather during each survey night at the Radar Met Low detector – Spring 2008

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Night of** | **Operated Okay?** | **big brown bat** | **hoary bat** | **silver-haired bat** | **silver-haired/big brown** | **eastern pipistrelle** | **eastern red bat** | **pipistrelle/red bat** | **MYSP** | **high-frequency** | **low-frequency** | **unknown** | **Total** | **Wind Speed (m/s)** | **Wind Direction (degrees)** | **Relative Humidity (%)** | **Temperature (celsius)** |
| 4/25/08 | Yes | | | | | | | | | | | | **0** | 6.5 | 84.6 | 69.5 | 2.3 |
| 4/26/08 | Yes | | | | | | | | | | | | **0** | 7.7 | 112.0 | 70.2 | 2.7 |
| 4/27/08 | Yes | | | | | | | | | | | | **0** | 4.8 | 168.3 | 68.3 | 3.8 |
| 4/28/08 | Yes | | | | | | | | | | | 1 | **1** | 11.3 | 145.4 | 71.4 | 5.0 |
| 4/29/08 | Yes | | | | | | | | | | | | **0** | 11.0 | 159.0 | 64.9 | 2.5 |
| 4/30/08 | Yes | | | | | | | | | | | | **0** | 8.2 | 324.0 | 62.8 | -2.3 |
| 5/1/08 | Yes | | | | | | | | | | | | **0** | 8.5 | 328.1 | 55.1 | -1.3 |
| 5/2/08 | Yes | | | | | | | | | | | | **0** | 6.2 | 104.4 | 66.0 | 2.4 |
| 5/3/08 | Yes | | | | | | | | | | | 1 | **1** | 7.3 | 182.0 | 58.6 | 4.6 |
| 5/4/08 | Yes | | | | | | | | | | | | **0** | 4.9 | 212.2 | 80.1 | 2.8 |
| 5/5/08 | Yes | | | | | | | | 1 | | | 1 | **2** | 2.6 | 306.9 | 73.9 | 9.1 |
| 5/6/08 | Yes | | | | | | | | 2 | | | | **2** | 5.6 | 292.4 | 50.3 | 11.4 |
| 5/7/08 | Yes | | | | | | | | 1 | | | | **1** | 6.0 | 205.2 | 42.5 | 9.1 |
| 5/8/08 | Yes | | | | | | | | | | | | **0** | 11.0 | 306.1 | 87.3 | 5.0 |
| 5/9/08 | Yes | | | | | | | | | | | | **0** | 8.4 | 66.8 | 75.8 | 5.3 |
| 5/10/08 | Yes | | | | | | | | | | | | **0** | 9.1 | 26.8 | 85.6 | 2.7 |
| 5/11/08 | Yes | | | | | | | | | | | | **0** | 8.0 | 72.5 | 74.1 | 4.2 |
| 5/12/08 | Yes | | | | | | | | | | | | **0** | 6.9 | 52.7 | 60.9 | 6.8 |
| 5/13/08 | Yes | | | | | | | | | | | 1 | **1** | 5.7 | 77.0 | 56.5 | 8.6 |
| 5/14/08 | Yes | | | | | | | | 1 | | | | **1** | 7.5 | 127.0 | 50.7 | 9.4 |
| 5/15/08 | Yes | | | | | | | | | | | | **0** | 9.5 | 319.6 | 77.5 | 9.6 |
| 5/16/08 | Yes | | | | | | | | 1 | | | | **1** | 7.2 | 48.1 | 53.8 | 10.2 |
| 5/17/08 | Yes | | | | | | | | | | | 1 | **1** | 7.9 | 236.7 | 77.8 | 8.3 |
| 5/18/08 | Yes | | | | | | | | 1 | | | | **1** | 7.1 | 178.4 | 66.0 | 9.8 |
| 5/19/08 | Yes | | | | | | | | | | | | **0** | 9.1 | 268.7 | 95.8 | 4.7 |
| 5/20/08 | Yes | | | | | | | | | | | | **0** | 2.4 | 131.3 | 72.2 | 8.4 |
| 5/21/08 | Yes | | | | | | | | | | | | **0** | 3.9 | 194.9 | 95.5 | 7.3 |
| 5/22/08 | Yes | | | | | | | | | | | | **0** | 8.5 | 329.1 | 96.0 | 6.2 |
| 5/23/08 | Yes | | | | | | | | | | | | **0** | 8.0 | 332.7 | 85.8 | 4.5 |
| 5/24/08 | Yes | | | | | | | | | | | | **0** | 8.1 | 333.9 | 58.2 | 8.4 |
| 5/25/08 | Yes | | | | | | | | | | | | **0** | 9.5 | 247.8 | 49.3 | 12.8 |
| 5/26/08 | Yes | | | | | | | | | | | | **0** | 8.8 | 197.6 | 91.8 | 10.5 |
| 5/27/08 | Yes | | | | | | | | | | | | **0** | 10.5 | 312.2 | 70.3 | 3.7 |
| 5/28/08 | Yes | | | | | | | | | | | | **0** | 9.9 | 255.5 | 54.8 | 8.1 |
| 5/29/08 | Yes | | | | | | | | | | | | **0** | 8.8 | 322.6 | 55.7 | 5.5 |
| 5/30/08 | Yes | | | | | | | | 1 | | | | **1** | 7.6 | 223.8 | 59.5 | 10.0 |
| 5/31/08 | Yes | | | | | | | | | | | | **0** | 6.6 | 213.3 | 98.3 | 9.6 |
| **By Species** | | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **8** | **0** | **0** | **5** | **13** | | | | |
| **By Guild** | | **0** | | | | **0** | | | **8** | **5** | | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | | |

**Appendix B Table 3**. Summary of acoustic bat data and weather during each survey night at the Radar Tree detector – Spring 2008

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Night of** | **Operated Okay?** | **big brown bat** | **hoary bat** | **silver-haired bat** | **silver-haired/big brown** | **eastern pipistrelle** | **eastern red bat** | **pipistrelle/red bat** | **MYSP** | **high-frequency** | **low-frequency** | **unknown** | **Total** | **Wind Speed (m/s)** | **Wind Direction (degrees)** | **Relative Humidity (%)** | **Temperature (celsius)** |
| 4/25/08 | No | | | | | | | | | | | | **0** | 6.5 | 84.6 | 69.5 | 2.3 |
| 4/26/08 | No | | | | | | | | | | | | **0** | 7.7 | 112.0 | 70.2 | 2.7 |
| 4/27/08 | No | | | | | | | | | | | | **0** | 4.8 | 168.3 | 68.3 | 3.8 |
| 4/28/08 | No | | | | | | | | | | | | **0** | 11.3 | 145.4 | 71.4 | 5.0 |
| 4/29/08 | No | | | | | | | | | | | | **0** | 11.0 | 159.0 | 64.9 | 2.5 |
| 4/30/08 | No | | | | | | | | | | | | **0** | 8.2 | 324.0 | 62.8 | -2.3 |
| 5/1/08 | No | | | | | | | | | | | | **0** | 8.5 | 328.1 | 55.1 | -1.3 |
| 5/2/08 | No | | | | | | | | | | | | **0** | 6.2 | 104.4 | 66.0 | 2.4 |
| 5/3/08 | No | | | | | | | | | | | | **0** | 7.3 | 182.0 | 58.6 | 4.6 |
| 5/4/08 | No | | | | | | | | | | | | **0** | 4.9 | 212.2 | 80.1 | 2.8 |
| 5/5/08 | No | | | | | | | | | | | | **0** | 2.6 | 306.9 | 73.9 | 9.1 |
| 5/6/08 | No | | | | | | | | | | | | **0** | 5.6 | 292.4 | 50.3 | 11.4 |
| 5/7/08 | No | | | | | | | | | | | | **0** | 6.0 | 205.2 | 42.5 | 9.1 |
| 5/8/08 | Yes | | | | | | | | | | | | **0** | 11.0 | 306.1 | 87.3 | 5.0 |
| 5/9/08 | Yes | | | | | | | | | | | | **0** | 8.4 | 66.8 | 75.8 | 5.3 |
| 5/10/08 | Yes | | | | | | | | | | | | **0** | 9.1 | 26.8 | 85.6 | 2.7 |
| 5/11/08 | Yes | | | | | | | | | | | | **0** | 8.0 | 72.5 | 74.1 | 4.2 |
| 5/12/08 | Yes | | | | | | | | | | | | **0** | 6.9 | 52.7 | 60.9 | 6.8 |
| 5/13/08 | Yes | | | | | | | | 1 | | | 3 | **4** | 5.7 | 77.0 | 56.5 | 8.6 |
| 5/14/08 | Yes | | | | | | | | 41 | | | 11 | **52** | 7.5 | 127.0 | 50.7 | 9.4 |
| 5/15/08 | Yes | | | | | | | | 2 | | | | **2** | 9.5 | 319.6 | 77.5 | 9.6 |
| 5/16/08 | Yes | | | | | | | | 41 | | | 2 | **43** | 7.2 | 48.1 | 53.8 | 10.2 |
| 5/17/08 | Yes | | | | | | | | | | | | **0** | 7.9 | 236.7 | 77.8 | 8.3 |
| 5/18/08 | Yes | | | | | | | | | | | | **0** | 7.1 | 178.4 | 66.0 | 9.8 |
| 5/19/08 | Yes | | | | | | | | | | | | **0** | 9.1 | 268.7 | 95.8 | 4.7 |
| 5/20/08 | Yes | | | | | | | | | | | | **0** | 2.4 | 131.3 | 72.2 | 8.4 |
| 5/21/08 | Yes | | | | | | | | | | | | **0** | 3.9 | 194.9 | 95.5 | 7.3 |
| 5/22/08 | Yes | | | | | | | | | | | | **0** | 8.5 | 329.1 | 96.0 | 6.2 |
| 5/23/08 | Yes | | | | | | | | | | | | **0** | 8.0 | 332.7 | 85.8 | 4.5 |
| 5/24/08 | Yes | | | | | | | | 26 | | | 10 | **36** | 8.1 | 333.9 | 58.2 | 8.4 |
| 5/25/08 | Yes | | | | | | | | 43 | | | 17 | **60** | 9.5 | 247.8 | 49.3 | 12.8 |
| 5/26/08 | Yes | | | | | | | | | | | | **0** | 8.8 | 197.6 | 91.8 | 10.5 |
| 5/27/08 | Yes | | | | | | | | | | | | **0** | 10.5 | 312.2 | 70.3 | 3.7 |
| 5/28/08 | Yes | | | | | | | | | | | | **0** | 9.9 | 255.5 | 54.8 | 8.1 |
| 5/29/08 | Yes | | | | | | | | 11 | | | 6 | **17** | 8.8 | 322.6 | 55.7 | 5.5 |
| 5/30/08 | Yes | | | | | | | | 1 | | | 3 | **4** | 7.6 | 223.8 | 59.5 | 10.0 |
| 5/31/08 | Yes | | | | | | | | | | | | **0** | 6.6 | 213.3 | 98.3 | 9.6 |
| **By Species** | | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **166** | **0** | **0** | **52** | **218** | | | | |
| **By Guild** | | **0** | | | | **0** | | | **166** | **52** | | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | | |

**Appendix B Table 4**. Summary of acoustic bat data and weather during each survey night at the South Tree detector –Spring 2008

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Night of** | **Operated Okay?** | **big brown bat** | **hoary bat** | **silver-haired bat** | **silver-haired/big brown** | **eastern pipistrelle** | **eastern red bat** | **pipistrelle/red bat** | **MYSP** | **high-frequency** | **low-frequency** | **unknown** | **Total** | **Wind Speed (m/s)** | **Wind Direction (degrees)** | **Relative Humidity (%)** | **Temperature (celsius)** |
| 5/1/08 | Yes | | | | | | | | | | | | **0** | 8.5 | 328.1 | 69.5 | -1.3 |
| 5/2/08 | Yes | | | | | | | | 11 | | | 7 | **18** | 6.2 | 104.4 | 70.2 | 2.4 |
| 5/3/08 | Yes | | | | | | | | 8 | | | 18 | **26** | 7.3 | 182.0 | 68.3 | 4.6 |
| 5/4/08 | Yes | | | | | | | | | | | | **0** | 4.9 | 212.2 | 71.4 | 2.8 |
| 5/5/08 | Yes | | | | | | | | 5 | | | 5 | **10** | 2.6 | 306.9 | 64.9 | 9.1 |
| 5/6/08 | Yes | | | | | | | | 44 | | | 14 | **58** | 5.6 | 292.4 | 62.8 | 11.4 |
| 5/7/08 | Yes | | | | | | | | 13 | | | 1 | **14** | 6.0 | 205.2 | 55.1 | 9.1 |
| 5/8/08 | Yes | | | | | | | | | | | 1 | **1** | 11.0 | 306.1 | 66.0 | 5.0 |
| 5/9/08 | Yes | | | | | | | | | | | | **0** | 8.4 | 66.8 | 58.6 | 5.3 |
| 5/10/08 | Yes | | | | | | | | | | | | **0** | 9.1 | 26.8 | 80.1 | 2.7 |
| 5/11/08 | Yes | | | | | | | | 1 | | | 1 | **2** | 8.0 | 72.5 | 73.9 | 4.2 |
| 5/12/08 | Yes | | | | | | | | 8 | | | 9 | **17** | 6.9 | 52.7 | 50.3 | 6.8 |
| 5/13/08 | Yes | | | | | | | | 15 | | | 24 | **39** | 5.7 | 77.0 | 42.5 | 8.6 |
| 5/14/08 | Yes | | | | | | 1 | | 10 | | | 10 | **21** | 7.5 | 127.0 | 87.3 | 9.4 |
| 5/15/08 | Yes | | | | | | | | 3 | | | 5 | **8** | 9.5 | 319.6 | 75.8 | 9.6 |
| 5/16/08 | Yes | | | | | | 1 | | 5 | | | 9 | **15** | 7.2 | 48.1 | 85.6 | 10.2 |
| 5/17/08 | Yes | | | | | | | | | | | 3 | **3** | 7.9 | 236.7 | 74.1 | 8.3 |
| 5/18/08 | Yes | | | | | | | | | | | | **0** | 7.1 | 178.4 | 60.9 | 9.8 |
| 5/19/08 | Yes | | | | | | | | | | | | **0** | 9.1 | 268.7 | 56.5 | 4.7 |
| 5/20/08 | Yes | | | | | | | | 2 | | | | **2** | 2.4 | 131.3 | 50.7 | 8.4 |
| 5/21/08 | Yes | | | | | | | | 1 | | | | **1** | 3.9 | 194.9 | 77.5 | 7.3 |
| 5/22/08 | Yes | | | | | | | | 1 | | | | **1** | 8.5 | 329.1 | 53.8 | 6.2 |
| 5/23/08 | Yes | | | | | | | | 2 | | | | **2** | 8.0 | 332.7 | 77.8 | 4.5 |
| 5/24/08 | Yes | | | | | | | | 2 | | | | **2** | 8.1 | 333.9 | 66.0 | 8.4 |
| 5/25/08 | Yes | | | | | | | | 10 | | | 4 | **14** | 9.5 | 247.8 | 95.8 | 12.8 |
| 5/26/08 | Yes | | | | | | | | | | | | **0** | 8.8 | 197.6 | 72.2 | 10.5 |
| 5/27/08 | Yes | | | | | | | | | | | | **0** | 10.5 | 312.2 | 95.5 | 3.7 |
| 5/28/08 | Yes | | | | | | | | 2 | | | | **2** | 9.9 | 255.5 | 96.0 | 8.1 |
| 5/29/08 | Yes | | | | | | | | 1 | | | 1 | **2** | 8.8 | 322.6 | 85.8 | 5.5 |
| 5/30/08 | Yes | | | | | | | | 2 | | | 1 | **3** | 7.6 | 223.8 | 58.2 | 10.0 |
| 5/31/08 | Yes | | | | | | | | | | | | **0** | 6.6 | 213.3 | 49.3 | 9.6 |
| **By Species** | | **0** | **0** | **0** | **0** | **0** | **2** | **0** | **146** | **0** | **0** | **113** | **261** | | | | |
| **By Guild** | | **0** | | | | **2** | | | **146** | **113** | | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | | |

**Appendix B Table 5**. Summary of acoustic bat data and weather during each survey night at the Road Tree detector – Spring 2008

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Night of** | **Operated Okay?** | **big brown bat** | **hoary bat** | **silver-haired bat** | **silver-haired/big brown** | **eastern pipistrelle** | **eastern red bat** | **pipistrelle/red bat** | **MYSP** | **high-frequency** | **low-frequency** | **unknown** | **Total** | **Wind Speed (m/s)** | **Wind Direction (degrees)** | **Relative Humidity (%)** | **Temperature (celsius)** |
| 5/1/08 | Yes | | | | | | | | | | | | **0** | 8.5 | 328.1 | 55.1 | -1.3 |
| 5/2/08 | Yes | | | | | | | | | | | 5 | **5** | 6.2 | 104.4 | 66.0 | 2.4 |
| 5/3/08 | Yes | | | | | | | | | | | 1 | **1** | 7.3 | 182.0 | 58.6 | 4.6 |
| 5/4/08 | Yes | | | | | | | | | | | | **0** | 4.9 | 212.2 | 80.1 | 2.8 |
| 5/5/08 | Yes | | | | | | | | | | | | **0** | 2.6 | 306.9 | 73.9 | 9.1 |
| 5/6/08 | Yes | | | | | | | | | | | | **0** | 5.6 | 292.4 | 50.3 | 11.4 |
| 5/7/08 | Yes | | | | | | | | | | | 1 | **1** | 6.0 | 205.2 | 42.5 | 9.1 |
| 5/8/08 | Yes | | | | | | | | | | | 2 | **2** | 11.0 | 306.1 | 87.3 | 5.0 |
| 5/9/08 | Yes | | | | | | | | 2 | | | 2 | **4** | 8.4 | 66.8 | 75.8 | 5.3 |
| 5/10/08 | Yes | | | | | | | | | | | | **0** | 9.1 | 26.8 | 85.6 | 2.7 |
| 5/11/08 | Yes | | | | | | | | 5 | | | 1 | **6** | 8.0 | 72.5 | 74.1 | 4.2 |
| 5/12/08 | Yes | | | | | | | | 12 | | | 12 | **24** | 6.9 | 52.7 | 60.9 | 6.8 |
| 5/13/08 | Yes | | | | | | | | 10 | | | 6 | **16** | 5.7 | 77.0 | 56.5 | 8.6 |
| 5/14/08 | Yes | | | | | | | | 9 | | | 11 | **20** | 7.5 | 127.0 | 50.7 | 9.4 |
| 5/15/08 | Yes | | | | | | | | | | | | **0** | 9.5 | 319.6 | 77.5 | 9.6 |
| 5/16/08 | Yes | | | | | | | | 2 | | | 6 | **8** | 7.2 | 48.1 | 53.8 | 10.2 |
| 5/17/08 | Yes | | | | 1 | | | | | | | | **1** | 7.9 | 236.7 | 77.8 | 8.3 |
| 5/18/08 | Yes | | | | | | | | 1 | | | | **1** | 7.1 | 178.4 | 66.0 | 9.8 |
| 5/19/08 | Yes | | | | | | | | | | | | **0** | 9.1 | 268.7 | 95.8 | 4.7 |
| 5/20/08 | Yes | | | | | | | | 6 | | | | **6** | 2.4 | 131.3 | 72.2 | 8.4 |
| 5/21/08 | Yes | | | | | | | | 2 | | | 1 | **3** | 3.9 | 194.9 | 95.5 | 7.3 |
| 5/22/08 | Yes | | | | | | | | | | | | **0** | 8.5 | 329.1 | 96.0 | 6.2 |
| 5/23/08 | Yes | | | | | | | | | | | | **0** | 8.0 | 332.7 | 85.8 | 4.5 |
| 5/24/08 | Yes | | | | | | | | | | | 2 | **2** | 8.1 | 333.9 | 58.2 | 8.4 |
| 5/25/08 | Yes | | | | | | | | | | | | **0** | 9.5 | 247.8 | 49.3 | 12.8 |
| 5/26/08 | Yes | | | | | | | | | | | | **0** | 8.8 | 197.6 | 91.8 | 10.5 |
| 5/27/08 | Yes | | | | | | | | | | | | **0** | 10.5 | 312.2 | 70.3 | 3.7 |
| 5/28/08 | Yes | | | | | | | | 1 | | | 1 | **2** | 9.9 | 255.5 | 54.8 | 8.1 |
| 5/29/08 | Yes | | | | | | | | 2 | | | | **2** | 8.8 | 322.6 | 55.7 | 5.5 |
| 5/30/08 | Yes | | | | | | | | | | | 1 | **1** | 7.6 | 223.8 | 59.5 | 10.0 |
| 5/31/08 | Yes | | | | | | | | | | | | **0** | 6.6 | 213.3 | 98.3 | 9.6 |
| **By Species** | | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **52** | **0** | **0** | **52** | **105** | | | | |
| **By Guild** | | **1** | | | | **0** | | | **52** | **52** | | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | | |

**Appendix B Table 6**. Summary of acoustic bat data and weather during each survey night at the Radar Met High detector – Summer 2008

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Night of** | **Operated Okay?** | **big brown bat** | **hoary bat** | **silver-haired bat** | **silver-haired/big brown** | **eastern pipistrelle** | **eastern red bat** | **pipistrelle/red bat** | **MYSP** | **high-frequency** | **low-frequency** | **unknown** | **Total** | **Wind Speed (m/s)** | **Wind Direction (degrees)** | **Temperature (celsius)** |
| 6/1/08 | yes | | | | | | | | | | | | **0** | 8.1 | 340.3 | 8.0 |
| 6/2/08 | yes | | | | | | | | | | | | **0** | 7.1 | 268.6 | 11.2 |
| 6/3/08 | yes | | | | | | | | | | | | **0** | 3.9 | 323.2 | 11.1 |
| 6/4/08 | yes | | | | | | | | | | | | **0** | 5.5 | 74.4 | 8.0 |
| 6/5/08 | yes | | | | | | | | | | | | **0** | 7.8 | 184.2 | 11.4 |
| 6/6/08 | yes | | | | | | | | | | | | **0** | 5.5 | 216.2 | 8.3 |
| 6/7/08 | yes | | | | | | | | | | 1 | | **1** | 8.8 | 249.2 | 17.7 |
| 6/8/08 | yes | | | | | | | | | | | | **0** | 9.3 | 316.1 | 17.8 |
| 6/9/08 | yes | | | | | | | | | 1 | | | **1** | 7.3 | 127.8 | 16.4 |
| 6/10/08 | yes | | | | | | | | | | | | **0** | 7.4 | 188.5 | 15.1 |
| 6/11/08 | yes | | | | | | | | | | | | **0** | 10.1 | 309.7 | 11.0 |
| 6/12/08 | yes | | | | | | | | | | | | **0** | 11.2 | 321.8 | 11.3 |
| 6/13/08 | yes | | | | 1 | | | | 5 | 3 | 1 | | **10** | 4.8 | 39.0 | 13.7 |
| 6/14/08 | yes | | | | | | | | | | | | **0** | 6.4 | 105.5 | 12.8 |
| 6/15/08 | yes | | | | | | | | | | | | **0** | 4.9 | 153.4 | 12.8 |
| 6/16/08 | yes | | | | | | | | | | | | **0** | 8.0 | 156.4 | 11.9 |
| 6/17/08 | yes | | | | | | | | | | | | **0** | 4.9 | 128.2 | 11.5 |
| 6/18/08 | yes | | | | | | | | | | | | **0** | 5.2 | 162.0 | 10.3 |
| 6/19/08 | yes | | | | | | | | | 2 | | | **2** | 5.6 | 178.0 | 10.8 |
| 6/20/08 | yes | | | | | | | | 1 | | | | **1** | 5.3 | 219.6 | 12.1 |
| 6/21/08 | yes | | | | | | | | | | | | **0** | 6.8 | 231.8 | 15.4 |
| 6/22/08 | yes | | | | 1 | | | | | | | | **1** | 7.3 | 196.7 | 15.1 |
| 6/23/08 | yes | | | | | | | | | | | | **0** | 7.5 | 242.0 | 16.1 |
| 6/24/08 | yes | | | | | | | | | | 3 | | **3** | 9.8 | 315.0 | 12.9 |
| 6/25/08 | yes | | | | | | | | | | | | **0** | 8.6 | 253.9 | 16.9 |
| 6/26/08 | yes | | | 3 | | | | | 3 | 3 | 1 | | **10** | 2.5 | 121.0 | 15.1 |
| 6/27/08 | yes | | | | | | | | 1 | | | | **1** | 5.8 | 109.1 | 11.3 |
| 6/28/08 | yes | | | | | | | | | | | | **0** | 10.0 | 118.2 | 11.7 |
| 6/29/08 | yes | | | | | | | | | | | | **0** | 6.2 | 148.1 | 14.0 |
| 6/30/08 | yes | | | | | | | | | | | | **0** | 6.6 | 255.6 | 17.7 |
| 7/1/08 | yes | | | | | | | | | 2 | | | **2** | 4.5 | 284.6 | 18.2 |
| 7/2/08 | yes | | | | | | | | | | | | **0** | 7.7 | 204.0 | 17.4 |
| 7/3/08 | yes | | | | | | | | | | | | **0** | 8.2 | 305.7 | 13.5 |
| 7/4/08 | yes | | | | | | | | | 1 | 1 | | **2** | 7.0 | 278.7 | 15.7 |
| 7/5/08 | yes | | | | | | | | | | | | **0** | 8.3 | 244.5 | 17.2 |
| 7/6/08 | yes | | | | | | | | | | | | **0** | 8.4 | 240.3 | 18.4 |
| 7/7/08 | yes | | | | | | | | | | | | **0** | 8.2 | 261.6 | 21.6 |
| 7/8/08 | yes | | | | | | | | | | | | **0** | 7.3 | 218.2 | 21.3 |
| 7/9/08 | yes | | | | | | | | | | | | **0** | 5.5 | 265.5 | 18.4 |
| 7/10/08 | yes | | | | | | | | | 1 | 1 | | **2** | 9.9 | 291.0 | 13.8 |
| 7/11/08 | n/o | | | | | | | | | | | | **0** | 6.2 | 322.2 | 14.3 |
| 7/12/08 | n/o | | | | | | | | | | | | **0** | 9.2 | 191.2 | 15.8 |
| 7/13/08 | n/o | | | | | | | | | | | | **0** | 11.9 | 184.2 | 16.6 |
| 7/14/08 | n/o | | | | | | | | | | | | **0** | 6.7 | 261.6 | 17.5 |
| 7/15/08 | n/o | | | | | | | | | | | | **0** | 6.7 | 296.9 | 16.9 |
| 7/16/08 | n/o | | | | | | | | | | | | **0** | 5.8 | 237.4 | 18.7 |
| 7/17/08 | n/o | | | | | | | | | | | | **0** | 4.8 | 26.1 | 17.8 |
| 7/18/08 | n/o | | | | | | | | | | | | **0** | 2.4 | 179.6 | 15.3 |
| 7/19/08 | n/o | | | | | | | | | | | | **0** | 3.3 | 248.6 | 15.9 |
| 7/20/08 | n/o | | | | | | | | | | | | **0** | 4.2 | 130.9 | 16.9 |
| 7/21/08 | n/o | | | | | | | | | | | | **0** | 5.8 | 81.2 | 16.4 |
| 7/22/08 | n/o | | | | | | | | | | | | **0** | 6.5 | 87.6 | 14.5 |
| 7/23/08 | n/o | | | | | | | | | | | | **0** | 8.7 | 119.0 | 16.5 |
| 7/24/08 | n/o | | | | | | | | | | | | **0** | 11.1 | 162.1 | 19.1 |
| 7/25/08 | n/o | | | | | | | | | | | | **0** | 6.0 | 235.7 | 17.3 |
| 7/26/08 | n/o | | | | | | | | | | | | **0** | 8.5 | 186.7 | 16.5 |
| 7/27/08 | n/o | | | | | | | | | | | | **0** | 5.3 | 183.6 | 17.2 |
| 7/28/08 | n/o | | | | | | | | | | | | **0** | 5.9 | 230.5 | 16.7 |
| 7/29/08 | n/o | | | | | | | | | | | | **0** | 8.4 | 305.8 | 14.8 |
| 7/30/08 | n/o | | | | | | | | | | | | **0** | 4.4 | 271.1 | 17.9 |
| 7/31/08 | n/o | | | | | | | | | | | | **0** | 6.7 | 136.4 | 15.9 |
| 8/1/08 | n/o | | | | | | | | | | | | **0** | 6.3 | 152.0 | 17.1 |
| 8/2/08 | n/o | | | | | | | | | | | | **0** | 6.8 | 138.2 | 16.9 |
| 8/3/08 | n/o | | | | | | | | | | | | **0** | 4.8 | 84.9 | 15.5 |
| 8/4/08 | n/o | | | | | | | | | | | | **0** | 8.2 | 16.2 | 12.2 |
| 8/5/08 | yes | | | | | | | | | | | | **0** | 4.3 | 177.0 | 13.1 |
| 8/6/08 | yes | | | | | | | | | | | | **0** | 2.6 | 166.3 | 12.4 |
| 8/7/08 | yes | | | | | | | | | | | | **0** | 4.5 | 150.5 | 12.3 |
| 8/8/08 | yes | | | | | | | | | | | | **0** | 2.9 | 14.2 | 13.0 |
| 8/9/08 | yes | | | | | | | | | | | | **0** | 3.1 | 70.2 | 15.1 |
| 8/10/08 | yes | | | | | | | | | | | | **0** | 4.0 | 130.9 | 15.4 |
| 8/11/08 | yes | | | | | | | | 2 | 29 | 1 | | **32** | 3.3 | 126.8 | 13.7 |
| **By Species** | | **0** | **0** | **3** | **2** | **0** | **0** | **0** | **12** | **42** | **9** | **0** | **68** | | | |
| **By Guild** | | **5** | | | | **0** | | | **12** | **51** | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | |

**Appendix B Table 7**. Summary of acoustic bat data and weather during each survey night at the Radar Met Low detector – Summer 2008

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Night of | Operated Okay? | big brown bat | hoary bat | silver-haired bat | silver-haired/big brown | eastern pipistrelle | eastern red bat | pipistrelle/red bat | MYSP | high-frequency | low-frequency | unknown | Total | Wind Speed (m/s) | Wind Direction (degrees) | Temperature (celsius) |
| 6/1/08 | yes | | | | | | | | | 1 | | | **1** | 8.1 | 340.3 | 8.0 |
| 6/2/08 | yes | | | | | | | | | | | | **0** | 7.1 | 268.6 | 11.2 |
| 6/3/08 | yes | | | | | | | | | 2 | | | **2** | 3.9 | 323.2 | 11.1 |
| 6/4/08 | yes | | | | | | | | | | | | **0** | 5.5 | 74.4 | 8.0 |
| 6/5/08 | yes | | | | | | | | 1 | | | | **1** | 7.8 | 184.2 | 11.4 |
| 6/6/08 | yes | | | | | | | | | | | | **0** | 5.5 | 216.2 | 8.3 |
| 6/7/08 | yes | | | | | | | | | | | | **0** | 8.8 | 249.2 | 17.7 |
| 6/8/08 | yes | | | | | | | | | | | | **0** | 9.3 | 316.1 | 17.8 |
| 6/9/08 | yes | | | | | | | | | | | | **0** | 7.3 | 127.8 | 16.4 |
| 6/10/08 | yes | | | | | | | | | | | | **0** | 7.4 | 188.5 | 15.1 |
| 6/11/08 | yes | | | | | | | | | | | | **0** | 10.1 | 309.7 | 11.0 |
| 6/12/08 | yes | | | | | | | | | | | | **0** | 11.2 | 321.8 | 11.3 |
| 6/13/08 | yes | | | | | | | | 1 | 11 | 1 | | **13** | 4.8 | 39.0 | 13.7 |
| 6/14/08 | yes | | | | | | | | 2 | 2 | | | **4** | 6.4 | 105.5 | 12.8 |
| 6/15/08 | yes | | | | | | | | | | | | **0** | 4.9 | 153.4 | 12.8 |
| 6/16/08 | yes | | | | | | | | | | | | **0** | 8.0 | 156.4 | 11.9 |
| 6/17/08 | yes | | | | | | | | 1 | | | | **1** | 4.9 | 128.2 | 11.5 |
| 6/18/08 | yes | | | | | | | | | | | | **0** | 5.2 | 162.0 | 10.3 |
| 6/19/08 | yes | | | | | | | | 2 | 2 | | | **4** | 5.6 | 178.0 | 10.8 |
| 6/20/08 | yes | | | | | | | | | 1 | | | **1** | 5.3 | 219.6 | 12.1 |
| 6/21/08 | yes | | | | | | | | 1 | 1 | | | **2** | 6.8 | 231.8 | 15.4 |
| 6/22/08 | yes | | | | | | | | | | | | **0** | 7.3 | 196.7 | 15.1 |
| 6/23/08 | yes | | | | | | | | | 1 | | | **1** | 7.5 | 242.0 | 16.1 |
| 6/24/08 | yes | | | | 2 | | | | | | | | **2** | 9.8 | 315.0 | 12.9 |
| 6/25/08 | yes | | | | | | | | 2 | 2 | | | **4** | 8.6 | 253.9 | 16.9 |
| 6/26/08 | yes | | | | | | | | | | | | **0** | 2.5 | 121.0 | 15.1 |
| 6/27/08 | yes | | | | | | | | | | | | **0** | 5.8 | 109.1 | 11.3 |
| 6/28/08 | yes | | | | | | | | | | | | **0** | 10.0 | 118.2 | 11.7 |
| 6/29/08 | yes | | | | | | | | 1 | | | | **1** | 6.2 | 148.1 | 14.0 |
| 6/30/08 | yes | | | | | | | | | 3 | | | **3** | 6.6 | 255.6 | 17.7 |
| 7/1/08 | yes | | | | | | | | 1 | 11 | | | **12** | 4.5 | 284.6 | 18.2 |
| 7/2/08 | yes | | | | | | | | 1 | | | | **1** | 7.7 | 204.0 | 17.4 |
| 7/3/08 | yes | | | | | | | | 2 | 4 | | | **6** | 8.2 | 305.7 | 13.5 |
| 7/4/08 | yes | | | | | | | | 4 | 3 | | | **7** | 7.0 | 278.7 | 15.7 |
| 7/5/08 | yes | | | | | | | | | | | | **0** | 8.3 | 244.5 | 17.2 |
| 7/6/08 | yes | | | | | | | | | 1 | | | **1** | 8.4 | 240.3 | 18.4 |
| 7/7/08 | yes | | | | | | | | 2 | | | | **2** | 8.2 | 261.6 | 21.6 |
| 7/8/08 | yes | | | | | | | | | | | | **0** | 7.3 | 218.2 | 21.3 |
| 7/9/08 | yes | | | | | | | | | 3 | | | **3** | 5.5 | 265.5 | 18.4 |
| 7/10/08 | yes | | | | | | | 1 | | 1 | | | **2** | 9.9 | 291.0 | 13.8 |
| 7/11/08 | yes | | | | | | | | | | | | **0** | 6.2 | 322.2 | 14.3 |
| 7/12/08 | yes | | | | | | | | 2 | | | | **2** | 9.2 | 191.2 | 15.8 |
| 7/13/08 | yes | | | | | | | | | | | | **0** | 11.9 | 184.2 | 16.6 |
| 7/14/08 | yes | | | | | | | | | | | | **0** | 6.7 | 261.6 | 17.5 |
| 7/15/08 | yes | | | | | | | | | 2 | | | **2** | 6.7 | 296.9 | 16.9 |
| 7/16/08 | yes | | | | | | | | 1 | 2 | | | **3** | 5.8 | 237.4 | 18.7 |
| 7/17/08 | yes | | | | 1 | | | | 1 | | 2 | | **4** | 4.8 | 26.1 | 17.8 |
| 7/18/08 | yes | | | | | | | | 1 | | | | **1** | 2.4 | 179.6 | 15.3 |
| 7/19/08 | yes | | | | | | | | 4 | | | | **4** | 3.3 | 248.6 | 15.9 |
| 7/20/08 | yes | | | | 1 | | | | | 1 | | | **2** | 4.2 | 130.9 | 16.9 |
| 7/21/08 | yes | | | | | | | | | | | | **0** | 5.8 | 81.2 | 16.4 |
| 7/22/08 | yes | | | | | | | | | | | | **0** | 6.5 | 87.6 | 14.5 |
| 7/23/08 | yes | | | | | | | | | | | | **0** | 8.7 | 119.0 | 16.5 |
| 7/24/08 | yes | | | | | | | | 1 | | | | **1** | 11.1 | 162.1 | 19.1 |
| 7/25/08 | yes | | | | | | | | 1 | 1 | | | **2** | 6.0 | 235.7 | 17.3 |
| 7/26/08 | yes | | | | | | | | 1 | 2 | | | **3** | 8.5 | 186.7 | 16.5 |
| 7/27/08 | yes | | | | | | | | 1 | 1 | | | **2** | 5.3 | 183.6 | 17.2 |
| 7/28/08 | yes | | | | | | | | | | | | **0** | 5.9 | 230.5 | 16.7 |
| 7/29/08 | yes | | | | | | | | | | | | **0** | 8.4 | 305.8 | 14.8 |
| 7/30/08 | yes | | | | | | | | 1 | 2 | 1 | | **4** | 4.4 | 271.1 | 17.9 |
| 7/31/08 | yes | | | | | | | | 1 | 1 | | | **2** | 6.7 | 136.4 | 15.9 |
| 8/1/08 | yes | | | | | | | | 1 | | | | **1** | 6.3 | 152.0 | 17.1 |
| 8/2/08 | yes | | | | | | | | | | | | **0** | 6.8 | 138.2 | 16.9 |
| 8/3/08 | yes | | | | | | | | | | | | **0** | 4.8 | 84.9 | 15.5 |
| 8/4/08 | yes | | | | | | | | | | | | **0** | 8.2 | 16.2 | 12.2 |
| 8/5/08 | yes | | | | | | | | | 1 | | | **1** | 4.3 | 177.0 | 13.1 |
| 8/6/08 | yes | | | | | | | | | | | | **0** | 2.6 | 166.3 | 12.4 |
| 8/7/08 | yes | | | | | | | | | 1 | | | **1** | 4.5 | 150.5 | 12.3 |
| 8/8/08 | yes | | | | | | | | | | | | **0** | 2.9 | 14.2 | 13.0 |
| 8/9/08 | yes | | | | | | | | | | | | **0** | 3.1 | 70.2 | 15.1 |
| 8/10/08 | yes | | | | | | | | | 1 | | | **1** | 4.0 | 130.9 | 15.4 |
| 8/11/08 | yes | | | | | | | | 1 | 18 | | | **19** | 3.3 | 126.8 | 13.7 |
| **By Species** | | **0** | **0** | **0** | **4** | **0** | **0** | **1** | **38** | **82** | **4** | **0** | **129** | | | |
| **By Guild** | | **4** | | | | **1** | | | **38** | **86** | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | |

**Appendix B Table 8**. Summary of acoustic bat data and weather during each survey night at the Radar Met Tree detector – Summer 2008

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Night of** | **Operated Okay?** | **big brown bat** | **hoary bat** | **silver-haired bat** | **silver-haired/big brown** | **eastern pipistrelle** | **eastern red bat** | **pipistrelle/red bat** | **MYSP** | **high-frequency** | **low-frequency** | **unknown** | **Total** | **Wind Speed (m/s)** | **Wind Direction (degrees)** | **Temperature (celsius)** |
| 6/1/08 | yes | | | | | | | | | 14 | | | **14** | 8.1 | 340.3 | 8.0 |
| 6/2/08 | yes | | | | | | | | 4 | 31 | | | **35** | 7.1 | 268.6 | 11.2 |
| 6/3/08 | yes | | | | | | | | 22 | 13 | | | **35** | 3.9 | 323.2 | 11.1 |
| 6/4/08 | yes | | | | | | | | | 1 | | | **1** | 5.5 | 74.4 | 8.0 |
| 6/5/08 | yes | | | | | | | | 2 | 2 | | | **4** | 7.8 | 184.2 | 11.4 |
| 6/6/08 | yes | | | | | | | | | | | | **0** | 5.5 | 216.2 | 8.3 |
| 6/7/08 | yes | | | | | | | | 1 | 2 | | | **3** | 8.8 | 249.2 | 17.7 |
| 6/8/08 | yes | | | | | | | | 4 | 6 | | | **10** | 9.3 | 316.1 | 17.8 |
| 6/9/08 | yes | | | | | | | | | 3 | | | **3** | 7.3 | 127.8 | 16.4 |
| 6/10/08 | yes | | | | | | | | | | | | **0** | 7.4 | 188.5 | 15.1 |
| 6/11/08 | yes | | | | | | | | 25 | 12 | | | **37** | 10.1 | 309.7 | 11.0 |
| 6/12/08 | yes | | | | | | | | 69 | 93 | | | **162** | 11.2 | 321.8 | 11.3 |
| 6/13/08 | yes | 1 | | | | | | | 151 | 98 | 1 | | **251** | 4.8 | 39.0 | 13.7 |
| 6/14/08 | yes | | | | | | | | 54 | 34 | | | **88** | 6.4 | 105.5 | 12.8 |
| 6/15/08 | yes | | | | | | | | | 2 | | | **2** | 4.9 | 153.4 | 12.8 |
| 6/16/08 | yes | | | | | | | | | | | | **0** | 8.0 | 156.4 | 11.9 |
| 6/17/08 | yes | | | | | | | | 7 | 4 | | | **11** | 4.9 | 128.2 | 11.5 |
| 6/18/08 | yes | | | | | | | | | 2 | | | **2** | 5.2 | 162.0 | 10.3 |
| 6/19/08 | yes | | | | | | | | 13 | 11 | | | **24** | 5.6 | 178.0 | 10.8 |
| 6/20/08 | yes | | | | | | | | 15 | 18 | | | **33** | 5.3 | 219.6 | 12.1 |
| 6/21/08 | yes | | | | | | | | 15 | 11 | | | **26** | 6.8 | 231.8 | 15.4 |
| 6/22/08 | yes | | | | | | | | | 3 | | | **3** | 7.3 | 196.7 | 15.1 |
| 6/23/08 | yes | | | | | | | | | | | | **0** | 7.5 | 242.0 | 16.1 |
| 6/24/08 | yes | | | | | | | | 98 | 43 | 1 | | **142** | 9.8 | 315.0 | 12.9 |
| 6/25/08 | yes | | | | | | | | 34 | 20 | | | **54** | 8.6 | 253.9 | 16.9 |
| 6/26/08 | yes | | | | | | | | 1 | 2 | | | **3** | 2.5 | 121.0 | 15.1 |
| 6/27/08 | yes | | | | | | | | 1 | 2 | | | **3** | 5.8 | 109.1 | 11.3 |
| 6/28/08 | yes | | | | | | | | | | | | **0** | 10.0 | 118.2 | 11.7 |
| 6/29/08 | yes | | | | | | | | | | | | **0** | 6.2 | 148.1 | 14.0 |
| 6/30/08 | yes | | | | | | | | 192 | 93 | | | **285** | 6.6 | 255.6 | 17.7 |
| 7/1/08 | yes | | | | | | | | 221 | 108 | | | **329** | 4.5 | 284.6 | 18.2 |
| 7/2/08 | yes | | | | | | | | 1 | 2 | | | **3** | 7.7 | 204.0 | 17.4 |
| 7/3/08 | yes | | | | | | | | 278 | 135 | | | **413** | 8.2 | 305.7 | 13.5 |
| 7/4/08 | yes | | | | | | | | 571 | 122 | | | **693** | 7.0 | 278.7 | 15.7 |
| 7/5/08 | yes | | | | | | | | 24 | 5 | | | **29** | 8.3 | 244.5 | 17.2 |
| 7/6/08 | yes | | | | | | | | 1 | 2 | | | **3** | 8.4 | 240.3 | 18.4 |
| 7/7/08 | yes | | | | | | | | 24 | 25 | | | **49** | 8.2 | 261.6 | 21.6 |
| 7/8/08 | yes | | | | | | | | | | | | **0** | 7.3 | 218.2 | 21.3 |
| 7/9/08 | yes | | | | | | | | 61 | 36 | | | **97** | 5.5 | 265.5 | 18.4 |
| 7/10/08 | yes | | | | | | | | 173 | 59 | 1 | | **233** | 9.9 | 291.0 | 13.8 |
| 7/11/08 | yes | | | | | | 1 | | 217 | 104 | | | **322** | 6.2 | 322.2 | 14.3 |
| 7/12/08 | yes | | | | | | | | 8 | 6 | | | **14** | 9.2 | 191.2 | 15.8 |
| 7/13/08 | yes | | | | | | | | | | | | **0** | 11.9 | 184.2 | 16.6 |
| 7/14/08 | yes | | | | | | | | 43 | 13 | | | **56** | 6.7 | 261.6 | 17.5 |
| 7/15/08 | yes | | | | | | | | 372 | 103 | | | **475** | 6.7 | 296.9 | 16.9 |
| 7/16/08 | yes | | | | | | | | 5 | 5 | | | **10** | 5.8 | 237.4 | 18.7 |
| 7/17/08 | yes | | | | | | | | 31 | 9 | 1 | | **41** | 4.8 | 26.1 | 17.8 |
| 7/18/08 | yes | | | | | | | | 3 | 2 | | | **5** | 2.4 | 179.6 | 15.3 |
| 7/19/08 | yes | | | | | | 1 | 1 | 113 | 15 | | | **130** | 3.3 | 248.6 | 15.9 |
| 7/20/08 | yes | | | | | | | | 6 | 3 | | | **9** | 4.2 | 130.9 | 16.9 |
| 7/21/08 | yes | | | | | | | | 1 | 1 | | | **2** | 5.8 | 81.2 | 16.4 |
| 7/22/08 | yes | | | | | | | | 32 | 21 | 2 | | **55** | 6.5 | 87.6 | 14.5 |
| 7/23/08 | yes | | | | | | | | 4 | 7 | | | **11** | 8.7 | 119.0 | 16.5 |
| 7/24/08 | yes | | | | | | | | | 1 | | | **1** | 11.1 | 162.1 | 19.1 |
| 7/25/08 | yes | | | | | | | | 1 | 1 | | | **2** | 6.0 | 235.7 | 17.3 |
| 7/26/08 | yes | | | | | | | | | 2 | | | **2** | 8.5 | 186.7 | 16.5 |
| 7/27/08 | yes | | | | | | | | | 2 | | | **2** | 5.3 | 183.6 | 17.2 |
| 7/28/08 | yes | | | | | | | | 1 | 2 | | | **3** | 5.9 | 230.5 | 16.7 |
| 7/29/08 | yes | | | | | | | | 7 | 12 | | | **19** | 8.4 | 305.8 | 14.8 |
| 7/30/08 | yes | | | | | | | | 19 | 21 | | | **40** | 4.4 | 271.1 | 17.9 |
| 7/31/08 | yes | | | | | | | | 7 | 5 | | | **12** | 6.7 | 136.4 | 15.9 |
| 8/1/08 | yes | | | | | | | | | | | | **0** | 6.3 | 152.0 | 17.1 |
| 8/2/08 | yes | | | | | | | | 2 | 2 | | | **4** | 6.8 | 138.2 | 16.9 |
| 8/3/08 | yes | | | | | | | | 1 | 7 | | | **8** | 4.8 | 84.9 | 15.5 |
| 8/4/08 | yes | | | | | | | | 3 | 2 | | | **5** | 8.2 | 16.2 | 12.2 |
| 8/5/08 | yes | | | | | | | | 5 | 6 | | | **11** | 4.3 | 177.0 | 13.1 |
| 8/6/08 | yes | | | | | | | | 7 | 6 | | | **13** | 2.6 | 166.3 | 12.4 |
| 8/7/08 | yes | | | | | | | | 7 | 5 | | | **12** | 4.5 | 150.5 | 12.3 |
| 8/8/08 | yes | | | | | | | | | | | | **0** | 2.9 | 14.2 | 13.0 |
| 8/9/08 | yes | | | | | | | | 13 | 6 | | | **19** | 3.1 | 70.2 | 15.1 |
| 8/10/08 | yes | | | | | | | | 3 | 4 | | | **7** | 4.0 | 130.9 | 15.4 |
| 8/11/08 | yes | | | | | | | | 27 | 55 | | | **82** | 3.3 | 126.8 | 13.7 |
| **By Species** | | **1** | **0** | **0** | **0** | **0** | **2** | **1** | **3000** | **1442** | **6** | **0** | **4452** | | | |
| **By Guild** | | **1** | | | | **3** | | | **3000** | **1448** | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | |

**Appendix B Table 9**. Summary of acoustic bat data and weather during each survey night at the North Tree detector – Summer 2008

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Night of** | **Operated Okay?** | **big brown bat** | **hoary bat** | **silver-haired bat** | **silver-haired/big brown** | **eastern pipistrelle** | **eastern red bat** | **pipistrelle/red bat** | **MYSP** | **high-frequency** | **low-frequency** | **unknown** | **Total** | **Wind Speed (m/s)** | **Wind Direction (degrees)** | **Temperature (celsius)** |
| 6/1/08 | yes | | | | | | | | | | | | **0** | 8.1 | 340.3 | 8.0 |
| 6/2/08 | yes | | | | | | | | | | | | **0** | 7.1 | 268.6 | 11.2 |
| 6/3/08 | yes | | | | | | | | | | | | **0** | 3.9 | 323.2 | 11.1 |
| 6/4/08 | yes | | | | | | | | 1 | | | | **1** | 5.5 | 74.4 | 8.0 |
| 6/5/08 | yes | | | | | | | | 1 | 1 | | | **2** | 7.8 | 184.2 | 11.4 |
| 6/6/08 | yes | | | | | | | | | | | | **0** | 5.5 | 216.2 | 8.3 |
| 6/7/08 | yes | | 1 | | | | | | | | 1 | | **2** | 8.8 | 249.2 | 17.7 |
| 6/8/08 | yes | | | | | | | | 1 | 1 | | | **2** | 9.3 | 316.1 | 17.8 |
| 6/9/08 | yes | | | | | | | | | | | | **0** | 7.3 | 127.8 | 16.4 |
| 6/10/08 | yes | | | | | | | | | | | | **0** | 7.4 | 188.5 | 15.1 |
| 6/11/08 | yes | | | | | | | | | | 1 | | **1** | 10.1 | 309.7 | 11.0 |
| 6/12/08 | yes | | | | | | | | 1 | | | | **1** | 11.2 | 321.8 | 11.3 |
| 6/13/08 | yes | | | | | | | | 1 | | | | **1** | 4.8 | 39.0 | 13.7 |
| 6/14/08 | yes | | | | | | | | | | 1 | | **1** | 6.4 | 105.5 | 12.8 |
| 6/15/08 | yes | | | | | | | | | | 1 | | **1** | 4.9 | 153.4 | 12.8 |
| 6/16/08 | yes | | | | | | | | | | 1 | | **1** | 8.0 | 156.4 | 11.9 |
| 6/17/08 | yes | | 1 | | | | | | | | | | **1** | 4.9 | 128.2 | 11.5 |
| 6/18/08 | yes | | | | | | | | | | | | **0** | 5.2 | 162.0 | 10.3 |
| 6/19/08 | yes | | | | | | | | | 1 | 2 | | **3** | 5.6 | 178.0 | 10.8 |
| 6/20/08 | yes | | | | | | | | | | 1 | | **1** | 5.3 | 219.6 | 12.1 |
| 6/21/08 | yes | | | | | | | | 1 | 1 | | | **2** | 6.8 | 231.8 | 15.4 |
| 6/22/08 | yes | | | | | | | | | | | | **0** | 7.3 | 196.7 | 15.1 |
| 6/23/08 | yes | | | | | | | | | | | | **0** | 7.5 | 242.0 | 16.1 |
| 6/24/08 | yes | | | | 1 | | | | 3 | 1 | | | **5** | 9.8 | 315.0 | 12.9 |
| 6/25/08 | yes | | | | | | | | | 1 | | | **1** | 8.6 | 253.9 | 16.9 |
| 6/26/08 | yes | | | | | | | | 3 | 2 | | | **5** | 2.5 | 121.0 | 15.1 |
| 6/27/08 | yes | | | | | | | | 1 | | | | **1** | 5.8 | 109.1 | 11.3 |
| 6/28/08 | yes | | | | | | | | | | | | **0** | 10.0 | 118.2 | 11.7 |
| 6/29/08 | yes | | | | | | | | | | | | **0** | 6.2 | 148.1 | 14.0 |
| 6/30/08 | yes | | | | | | | | 3 | 2 | | | **5** | 6.6 | 255.6 | 17.7 |
| 7/1/08 | yes | | | | | | | | 6 | 4 | | | **10** | 4.5 | 284.6 | 18.2 |
| 7/2/08 | yes | | | | | | | | | 1 | 1 | | **2** | 7.7 | 204.0 | 17.4 |
| 7/3/08 | yes | | | | | | | | 3 | 2 | | | **5** | 8.2 | 305.7 | 13.5 |
| 7/4/08 | yes | | | | | | | | 10 | 11 | | | **21** | 7.0 | 278.7 | 15.7 |
| 7/5/08 | yes | | | | | | | | | 1 | | | **1** | 8.3 | 244.5 | 17.2 |
| 7/6/08 | yes | | | | | | | | | | | | **0** | 8.4 | 240.3 | 18.4 |
| 7/7/08 | yes | | | | | | | | | 2 | | | **2** | 8.2 | 261.6 | 21.6 |
| 7/8/08 | yes | | | | | | | | | | | | **0** | 7.3 | 218.2 | 21.3 |
| 7/9/08 | yes | | | | | | | | | | | | **0** | 5.5 | 265.5 | 18.4 |
| 7/10/08 | yes | | | | | | | | 1 | | | | **1** | 9.9 | 291.0 | 13.8 |
| **By Species** | | **0** | **2** | **0** | **1** | **0** | **0** | **0** | **36** | **31** | **9** | **0** | **79** | | | |
| **By Guild** | | **3** | | | | **0** | | | **36** | **40** | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | |

**Appendix B Table 10**. Summary of acoustic bat data and weather during each survey night at the South Tree detector – Summer 2008

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Night of** | **Operated Okay?** | **big brown bat** | **hoary bat** | **silver-haired bat** | **silver-haired/big brown** | **eastern pipistrelle** | **eastern red bat** | **pipistrelle/red bat** | **MYSP** | **high-frequency** | **low-frequency** | **unknown** | **Total** | **Wind Speed (m/s)** | **Wind Direction (degrees)** | **Temperature (celsius)** |
| 6/1/08 | yes | | | | | | | | 4 | 1 | | | **5** | 8.1 | 340.3 | 8.0 |
| 6/2/08 | yes | | | | 1 | | | | 7 | 2 | | | **10** | 7.1 | 268.6 | 11.2 |
| 6/3/08 | yes | | | | | | | | | 1 | | | **1** | 3.9 | 323.2 | 11.1 |
| 6/4/08 | yes | | | | | | | | | | | | **0** | 5.5 | 74.4 | 8.0 |
| 6/5/08 | yes | | | | | | | | 5 | | 1 | | **6** | 7.8 | 184.2 | 11.4 |
| 6/6/08 | yes | | | | | | | | | | | | **0** | 5.5 | 216.2 | 8.3 |
| 6/7/08 | yes | | | | | | | | 1 | | | | **1** | 8.8 | 249.2 | 17.7 |
| 6/8/08 | yes | 1 | | | | | | | 5 | 3 | 2 | | **11** | 9.3 | 316.1 | 17.8 |
| 6/9/08 | yes | | | | | | | | 2 | 4 | | | **6** | 7.3 | 127.8 | 16.4 |
| 6/10/08 | yes | | | | | | | | 1 | 1 | | | **2** | 7.4 | 188.5 | 15.1 |
| 6/11/08 | yes | | | | | | | | 1 | 1 | 1 | | **3** | 10.1 | 309.7 | 11.0 |
| 6/12/08 | yes | | | | | | | | 5 | 4 | | | **9** | 11.2 | 321.8 | 11.3 |
| 6/13/08 | yes | | | | | | | | 71 | 11 | 1 | | **83** | 4.8 | 39.0 | 13.7 |
| 6/14/08 | yes | | | | | | | | 18 | 5 | | | **23** | 6.4 | 105.5 | 12.8 |
| 6/15/08 | yes | | | | | | | | 6 | | | | **6** | 4.9 | 153.4 | 12.8 |
| 6/16/08 | yes | | | | | | | | | 2 | | | **2** | 8.0 | 156.4 | 11.9 |
| 6/17/08 | yes | | | | | | | | 2 | 1 | | | **3** | 4.9 | 128.2 | 11.5 |
| 6/18/08 | yes | | | | | | | | 2 | | | | **2** | 5.2 | 162.0 | 10.3 |
| 6/19/08 | yes | | | | | | | | 10 | 2 | | | **12** | 5.6 | 178.0 | 10.8 |
| 6/20/08 | yes | | | | | | | | 15 | | | | **15** | 5.3 | 219.6 | 12.1 |
| 6/21/08 | yes | | | | | | | | 75 | 9 | | | **84** | 6.8 | 231.8 | 15.4 |
| 6/22/08 | yes | | | | | | | | 10 | 2 | | | **12** | 7.3 | 196.7 | 15.1 |
| 6/23/08 | yes | | | | | | | | 7 | | 1 | | **8** | 7.5 | 242.0 | 16.1 |
| 6/24/08 | yes | | | | | | | | 36 | 8 | | | **44** | 9.8 | 315.0 | 12.9 |
| 6/25/08 | yes | | | | | | | | 28 | 10 | | | **38** | 8.6 | 253.9 | 16.9 |
| 6/26/08 | yes | | | | | | | | 1 | | | | **1** | 2.5 | 121.0 | 15.1 |
| 6/27/08 | yes | | | | | | | | 11 | 5 | | | **16** | 5.8 | 109.1 | 11.3 |
| 6/28/08 | yes | | | | | | | | 1 | | | | **1** | 10.0 | 118.2 | 11.7 |
| 6/29/08 | yes | | | | | | | | 1 | | 3 | | **4** | 6.2 | 148.1 | 14.0 |
| 6/30/08 | yes | | | | | | | | 21 | 5 | | | **26** | 6.6 | 255.6 | 17.7 |
| 7/1/08 | yes | | | | | | | | 17 | 9 | | | **26** | 4.5 | 284.6 | 18.2 |
| 7/2/08 | yes | | | | | | | | 17 | 1 | | | **18** | 7.7 | 204.0 | 17.4 |
| 7/3/08 | yes | | | | | | | | 76 | 28 | | | **104** | 8.2 | 305.7 | 13.5 |
| 7/4/08 | yes | | | | | | | | 248 | 29 | | | **277** | 7.0 | 278.7 | 15.7 |
| 7/5/08 | yes | | | | | | | | 71 | 10 | | | **81** | 8.3 | 244.5 | 17.2 |
| 7/6/08 | yes | | | | | | | | 16 | 6 | | | **22** | 8.4 | 240.3 | 18.4 |
| 7/7/08 | yes | | | | | | | | 21 | 4 | | | **25** | 8.2 | 261.6 | 21.6 |
| 7/8/08 | yes | | | | 1 | | | | 3 | | | | **4** | 7.3 | 218.2 | 21.3 |
| 7/9/08 | yes | | | | | | | | 21 | 13 | | | **34** | 5.5 | 265.5 | 18.4 |
| 7/10/08 | yes | | | | | | | | 126 | 13 | | | **139** | 9.9 | 291.0 | 13.8 |
| **By Species** | | **1** | **0** | **0** | **2** | **0** | **0** | **0** | **962** | **190** | **9** | **0** | **1164** | | | |
| **By Guild** | | **3** | | | | **0** | | | **962** | **199** | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | |

**Appendix B Table 11.** Summary of acoustic bat data and weather during each survey night at the Road Tree detector – Summer 2008

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Night of | Operated Okay? | big brown bat | hoary bat | silver-haired bat | silver-haired/big brown | eastern pipistrelle | eastern red bat | pipistrelle/red bat | MYSP | high-frequency | low-frequency | unknown | Total | Wind Speed (m/s) | Wind Direction (degrees) | Temperature (celsius) |
| 6/1/08 | yes | | | | | | | | 2 | 1 | | | **3** | 8.1 | 340.3 | 8.0 |
| 6/2/08 | yes | | | | | | | | | | | | **0** | 7.1 | 268.6 | 11.2 |
| 6/3/08 | yes | | | | | | | | 1 | 4 | | | **5** | 3.9 | 323.2 | 11.1 |
| 6/4/08 | yes | | | | | | | | | | | | **0** | 5.5 | 74.4 | 8.0 |
| 6/5/08 | yes | | | | | | | | | 1 | | | **1** | 7.8 | 184.2 | 11.4 |
| 6/6/08 | yes | | | | | | | | | 1 | | | **1** | 5.5 | 216.2 | 8.3 |
| 6/7/08 | yes | | | | 1 | | | | 2 | | 1 | | **4** | 8.8 | 249.2 | 17.7 |
| 6/8/08 | yes | | | | | | | | 1 | | | | **1** | 9.3 | 316.1 | 17.8 |
| 6/9/08 | yes | | | | | | | | 1 | 2 | | | **3** | 7.3 | 127.8 | 16.4 |
| 6/10/08 | yes | | | | | | | | | | | | **0** | 7.4 | 188.5 | 15.1 |
| 6/11/08 | yes | | | | | | | | 1 | | | | **1** | 10.1 | 309.7 | 11.0 |
| 6/12/08 | yes | | | | | | | | | | 1 | | **1** | 11.2 | 321.8 | 11.3 |
| 6/13/08 | yes | | | | | | | | 15 | 10 | | | **25** | 4.8 | 39.0 | 13.7 |
| 6/14/08 | yes | | | | 1 | | | | 4 | 4 | 1 | | **10** | 6.4 | 105.5 | 12.8 |
| 6/15/08 | yes | | | | | | | | 1 | 5 | 1 | | **7** | 4.9 | 153.4 | 12.8 |
| 6/16/08 | yes | | | | | | | | | | | | **0** | 8.0 | 156.4 | 11.9 |
| 6/17/08 | yes | | | | | | | | | | | | **0** | 4.9 | 128.2 | 11.5 |
| 6/18/08 | yes | | | | | | | | 2 | 1 | | | **3** | 5.2 | 162.0 | 10.3 |
| 6/19/08 | yes | | | | | | | | | 2 | | | **2** | 5.6 | 178.0 | 10.8 |
| 6/20/08 | yes | | | | | | | | 1 | | | | **1** | 5.3 | 219.6 | 12.1 |
| 6/21/08 | yes | | | | | | | | 2 | 3 | | | **5** | 6.8 | 231.8 | 15.4 |
| 6/22/08 | yes | | | | | | | | | | | | **0** | 7.3 | 196.7 | 15.1 |
| 6/23/08 | yes | | | | | | | | | | | | **0** | 7.5 | 242.0 | 16.1 |
| 6/24/08 | yes | | | | | | | | 1 | 1 | | | **2** | 9.8 | 315.0 | 12.9 |
| 6/25/08 | yes | | | | | | | | 1 | 1 | 1 | | **3** | 8.6 | 253.9 | 16.9 |
| 6/26/08 | yes | | | | | | | | 3 | 1 | | | **4** | 2.5 | 121.0 | 15.1 |
| 6/27/08 | yes | | | | | | | | 2 | 6 | | | **8** | 5.8 | 109.1 | 11.3 |
| 6/28/08 | yes | | | | | | | | | | | | **0** | 10.0 | 118.2 | 11.7 |
| 6/29/08 | yes | | | | | | | | 1 | 3 | | | **4** | 6.2 | 148.1 | 14.0 |
| 6/30/08 | yes | | | | | | | | 5 | 1 | | | **6** | 6.6 | 255.6 | 17.7 |
| 7/1/08 | yes | | | | | | | | 6 | 7 | | | **13** | 4.5 | 284.6 | 18.2 |
| 7/2/08 | yes | | | | | | | | | | | | **0** | 7.7 | 204.0 | 17.4 |
| 7/3/08 | yes | | | | | | | | 1 | 3 | | | **4** | 8.2 | 305.7 | 13.5 |
| 7/4/08 | yes | | | | | | | | 8 | 11 | | | **19** | 7.0 | 278.7 | 15.7 |
| 7/5/08 | yes | | | | | | | | 1 | 9 | | | **10** | 8.3 | 244.5 | 17.2 |
| 7/6/08 | yes | | | | | | | | 1 | | | | **1** | 8.4 | 240.3 | 18.4 |
| 7/7/08 | yes | | | | | | | | 5 | 8 | | | **13** | 8.2 | 261.6 | 21.6 |
| 7/8/08 | yes | | | | | | | | | | | | **0** | 7.3 | 218.2 | 21.3 |
| 7/9/08 | yes | | | | | | | | 2 | 1 | | | **3** | 5.5 | 265.5 | 18.4 |
| 7/10/08 | yes | | | | | | | | 1 | 2 | | | **3** | 9.9 | 291.0 | 13.8 |
| **By Species** | | **0** | **0** | **0** | **2** | **0** | **0** | **0** | **71** | **88** | **5** | **0** | **166** | | | |
| **By Guild** | | **2** | | | | **0** | | | **71** | **93** | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | |

**Appendix B Table 12. Summary of acoustic bat data and weather during each survey night at the North Met High detector – Summer 2008**

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Night of | Operated Okay? | big brown bat | hoary bat | silver-haired bat | silver-haired/big brown | eastern pipistrelle | eastern red bat | pipistrelle/red bat | MYSP | high-frequency | low-frequency | unknown | Total | Wind Speed (m/s) | Wind Direction (degrees) | Temperature (celsius) |
| 7/11/08 | yes | | | | | | | | | | | | **0** | 6.2 | 322.2 | 14.3 |
| 7/12/08 | yes | | | | | | | | | | | | **0** | 9.2 | 191.2 | 15.8 |
| 7/13/08 | yes | | | | | | | | | | | | **0** | 11.9 | 184.2 | 16.6 |
| 7/14/08 | yes | | | | | | | | | | | | **0** | 6.7 | 261.6 | 17.5 |
| 7/15/08 | yes | | | | | | | | | | 1 | | **1** | 6.7 | 296.9 | 16.9 |
| 7/16/08 | yes | | | | | | | | | | | | **0** | 5.8 | 237.4 | 18.7 |
| 7/17/08 | yes | | | | | | | | | | | | **0** | 4.8 | 26.1 | 17.8 |
| 7/18/08 | yes | | | | | | | | | | | | **0** | 2.4 | 179.6 | 15.3 |
| 7/19/08 | yes | | | | | | | | | | 1 | | **1** | 3.3 | 248.6 | 15.9 |
| 7/20/08 | yes | | | | | | | | | | | | **0** | 4.2 | 130.9 | 16.9 |
| 7/21/08 | yes | | | | | | | | | | | | **0** | 5.8 | 81.2 | 16.4 |
| 7/22/08 | yes | | | | | | | | | | | | **0** | 6.5 | 87.6 | 14.5 |
| 7/23/08 | yes | | | | | | | | | | | | **0** | 8.7 | 119.0 | 16.5 |
| 7/24/08 | yes | | | | | | | | | | | | **0** | 11.1 | 162.1 | 19.1 |
| 7/25/08 | yes | | | | | | | | | | | | **0** | 6.0 | 235.7 | 17.3 |
| 7/26/08 | yes | | | | | | | | | | | | **0** | 8.5 | 186.7 | 16.5 |
| 7/27/08 | yes | | | | | | | | | | | | **0** | 5.3 | 183.6 | 17.2 |
| 7/28/08 | yes | | | | | | | | | | | | **0** | 5.9 | 230.5 | 16.7 |
| 7/29/08 | yes | | | | | | | | | | | | **0** | 8.4 | 305.8 | 14.8 |
| 7/30/08 | yes | | | | | | | | | | | | **0** | 4.4 | 271.1 | 17.9 |
| 7/31/08 | yes | | | | | | | | | | | | **0** | 6.7 | 136.4 | 15.9 |
| 8/1/08 | yes | | | | | | | | | | | | **0** | 6.3 | 152.0 | 17.1 |
| 8/2/08 | yes | | | | | | | | | | | | **0** | 6.8 | 138.2 | 16.9 |
| 8/3/08 | yes | | | | | | | | | | | | **0** | 4.8 | 84.9 | 15.5 |
| 8/4/08 | yes | | | | | | | | | | | | **0** | 8.2 | 16.2 | 12.2 |
| 8/5/08 | yes | | | | | | | | | | | | **0** | 4.3 | 177.0 | 13.1 |
| 8/6/08 | yes | | | | | | | | | | | | **0** | 2.6 | 166.3 | 12.4 |
| 8/7/08 | yes | | | | | | | | | | | | **0** | 4.5 | 150.5 | 12.3 |
| 8/8/08 | yes | | | | | | | | | | | | **0** | 2.9 | 14.2 | 13.0 |
| 8/9/08 | yes | | | | | | | | | | 1 | | **1** | 3.1 | 70.2 | 15.1 |
| 8/10/08 | yes | | | | | | | | | | | | **0** | 4.0 | 130.9 | 15.4 |
| 8/11/08 | yes | | | | | | | | | | | | **0** | 3.3 | 126.8 | 13.7 |
| **By Species** | | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **3** | **0** | **3** | | | |
| **By Guild** | | **0** | | | | **0** | | | **0** | **3** | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | |

**Appendix B Table 13. Summary of acoustic bat data and weather during each survey night at the North Met Low detector – Summer 2008**

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Night of | Operated Okay? | big brown bat | hoary bat | silver-haired bat | silver-haired/big brown | eastern pipistrelle | eastern red bat | pipistrelle/red bat | MYSP | high-frequency | low-frequency | unknown | Total | Wind Speed (m/s) | Wind Direction (degrees) | Temperature (celsius) |
| 7/11/08 | yes | | | 1 | | | | | | | | | **1** | 6.2 | 322.2 | 14.3 |
| 7/12/08 | yes | | | | | | | | | | | | **0** | 9.2 | 191.2 | 15.8 |
| 7/13/08 | yes | | | | | | | | | | | | **0** | 11.9 | 184.2 | 16.6 |
| 7/14/08 | yes | | | | | | | | | | | | **0** | 6.7 | 261.6 | 17.5 |
| 7/15/08 | yes | | | | | | | | | | | | **0** | 6.7 | 296.9 | 16.9 |
| 7/16/08 | yes | | | | | | | | | | | | **0** | 5.8 | 237.4 | 18.7 |
| 7/17/08 | yes | | | | | | | | | 1 | | | **1** | 4.8 | 26.1 | 17.8 |
| 7/18/08 | yes | | | | | | | | | | | | **0** | 2.4 | 179.6 | 15.3 |
| 7/19/08 | yes | | | | | | | | | | | | **0** | 3.3 | 248.6 | 15.9 |
| 7/20/08 | yes | | | | | | | | | | | | **0** | 4.2 | 130.9 | 16.9 |
| 7/21/08 | yes | | | | | | | | | | | | **0** | 5.8 | 81.2 | 16.4 |
| 7/22/08 | yes | | | | | | | | | | | | **0** | 6.5 | 87.6 | 14.5 |
| 7/23/08 | yes | | | | | | | | | | | | **0** | 8.7 | 119.0 | 16.5 |
| 7/24/08 | yes | | | | | | | | | | | | **0** | 11.1 | 162.1 | 19.1 |
| 7/25/08 | yes | 1 | 1 | | | | | | | | | | **2** | 6.0 | 235.7 | 17.3 |
| 7/26/08 | yes | | | | | | | | | 1 | | | **1** | 8.5 | 186.7 | 16.5 |
| 7/27/08 | yes | | | | | | | | | | | | **0** | 5.3 | 183.6 | 17.2 |
| 7/28/08 | yes | | | | | | | | | | | | **0** | 5.9 | 230.5 | 16.7 |
| 7/29/08 | yes | | | | | | | | | | | | **0** | 8.4 | 305.8 | 14.8 |
| 7/30/08 | yes | | | | | | | | | 1 | | | **1** | 4.4 | 271.1 | 17.9 |
| 7/31/08 | yes | | | | | | | | | | | | **0** | 6.7 | 136.4 | 15.9 |
| 8/1/08 | yes | | | | | | | | | | | | **0** | 6.3 | 152.0 | 17.1 |
| 8/2/08 | yes | | | | | | | | | | | | **0** | 6.8 | 138.2 | 16.9 |
| 8/3/08 | yes | | | | | | | | | | | | **0** | 4.8 | 84.9 | 15.5 |
| 8/4/08 | yes | | | | | | | | | | | | **0** | 8.2 | 16.2 | 12.2 |
| 8/5/08 | yes | | | | | | | | | | | | **0** | 4.3 | 177.0 | 13.1 |
| 8/6/08 | yes | | | | | | | | | | | | **0** | 2.6 | 166.3 | 12.4 |
| 8/7/08 | yes | | | | | | | | | | | | **0** | 4.5 | 150.5 | 12.3 |
| 8/8/08 | yes | | | | | | | | | | | | **0** | 2.9 | 14.2 | 13.0 |
| 8/9/08 | yes | | | | | | | | 1 | | | | **1** | 3.1 | 70.2 | 15.1 |
| 8/10/08 | yes | | | | | | | | | | | | **0** | 4.0 | 130.9 | 15.4 |
| 8/11/08 | yes | | | | | | 1 | | | 1 | | | **2** | 3.3 | 126.8 | 13.7 |
| **By Species** | | **1** | **1** | **1** | **0** | **0** | **1** | **0** | **1** | **4** | **0** | **0** | **9** | | | |
| **By Guild** | | **3** | | | | **1** | | | **1** | **4** | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | |

**Appendix B Table 14**. Summary of acoustic bat data and weather during each survey night at the South Met detector – Summer 2008

| | | BBSHHB | | | | RBEP | | | MYSP | UNKN | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Night of | Operated Okay? | big brown bat | hoary bat | silver-haired bat | silver-haired/big brown | eastern pipistrelle | eastern red bat | pipistrelle/red bat | MYSP | high-frequency | low-frequency | unknown | Total | Wind Speed (m/s) | Wind Direction (degrees) | Temperature (celsius) |
| 7/11/08 | yes | | 1 | | | | | | | | | | **1** | 6.2 | 322.2 | 14.3 |
| 7/12/08 | yes | | | | | | | | | 1 | | | **1** | 9.2 | 191.2 | 15.8 |
| 7/13/08 | yes | | | | | | | | | | | | **0** | 11.9 | 184.2 | 16.6 |
| 7/14/08 | yes | | | | | | | 1 | | | | | **1** | 6.7 | 261.6 | 17.5 |
| 7/15/08 | yes | | | | | | | | | | | | **0** | 6.7 | 296.9 | 16.9 |
| 7/16/08 | yes | | | | | | | | | | | | **0** | 5.8 | 237.4 | 18.7 |
| 7/17/08 | yes | | | | | | | | | | | | **0** | 4.8 | 26.1 | 17.8 |
| 7/18/08 | yes | | 1 | | | | | | | | | | **1** | 2.4 | 179.6 | 15.3 |
| 7/19/08 | yes | | | | | | | | | | | | **0** | 3.3 | 248.6 | 15.9 |
| 7/20/08 | yes | | | | | | | | 1 | | | | **1** | 4.2 | 130.9 | 16.9 |
| 7/21/08 | yes | | | | | | | | | | | | **0** | 5.8 | 81.2 | 16.4 |
| 7/22/08 | yes | | | | | | | | | 1 | | | **1** | 6.5 | 87.6 | 14.5 |
| 7/23/08 | yes | | | | | | | | | | | | **0** | 8.7 | 119.0 | 16.5 |
| 7/24/08 | yes | | | | | | | | | | | | **0** | 11.1 | 162.1 | 19.1 |
| 7/25/08 | yes | | | | | | | | | 1 | | | **1** | 6.0 | 235.7 | 17.3 |
| 7/26/08 | yes | | | | | | | | | | | | **0** | 8.5 | 186.7 | 16.5 |
| 7/27/08 | yes | | | | | | | | | | | | **0** | 5.3 | 183.6 | 17.2 |
| 7/28/08 | yes | | | | | | | | | | 2 | | **2** | 5.9 | 230.5 | 16.7 |
| 7/29/08 | yes | | | | | | | | | | | | **0** | 8.4 | 305.8 | 14.8 |
| 7/30/08 | yes | | | | | | | | | | | | **0** | 4.4 | 271.1 | 17.9 |
| 7/31/08 | yes | | | | | | | | | | | | **0** | 6.7 | 136.4 | 15.9 |
| 8/1/08 | yes | | | | | | | | | | | | **0** | 6.3 | 152.0 | 17.1 |
| 8/2/08 | yes | | | | | | | | | | | | **0** | 6.8 | 138.2 | 16.9 |
| 8/3/08 | yes | | | | | | | | | 1 | | | **1** | 4.8 | 84.9 | 15.5 |
| 8/4/08 | yes | | | | | | | | | | | | **0** | 8.2 | 16.2 | 12.2 |
| 8/5/08 | yes | | | | | | | | | | 2 | | **2** | 4.3 | 177.0 | 13.1 |
| 8/6/08 | yes | | | | | | | | | | | | **0** | 2.6 | 166.3 | 12.4 |
| 8/7/08 | yes | 1 | | | | | | | | | | | **1** | 4.5 | 150.5 | 12.3 |
| 8/8/08 | yes | | | | | | | | | | | | **0** | 2.9 | 14.2 | 13.0 |
| 8/9/08 | yes | | 1 | | | | | | | | | | **1** | 3.1 | 70.2 | 15.1 |
| 8/10/08 | yes | | | | | | | | | | 1 | | **1** | 4.0 | 130.9 | 15.4 |
| 8/11/08 | yes | | | | | | | | 1 | 17 | | | **18** | 3.3 | 126.8 | 13.7 |
| **By Species** | | **1** | **3** | **0** | **0** | **0** | **0** | **1** | **2** | **21** | **5** | **0** | **33** | | | |
| **By Guild** | | **4** | | | | **1** | | | **2** | **26** | | | | | | |
| | | **BBSHHB** | | | | **RBEP** | | | **MYSP** | **UNKN** | | | **Total** | | | |

**Appendix C Table 14.** Summary of available spring bat detector surveys (results reported for individual detectors)

| Year | Project | State | City | Habitat | Height (m) | Detector Nights | Start | End | Calls | Rate | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tree or low met detectors (under 15 m)** | | | | | | | | | | | |
| 2005 | Deerfield | VT | Searsburg | forest edge | 15 | 40 | 4/19 | 6/15 | 4 | 0.07 | Woodlot 2005g |
| 2005 | Sheffield | VT | Sheffield | forest edge | 10 | 4 | 5/12 | 5/29 | 0 | 0 | Woodlot 2006h |
| 2006 | Howard | NY | Howard | field | 8 | 35 | 4/15 | 6/3 | 29 | 0.8 | Woodlot 2006d |
| 2006 | Lempster | NH | Lempster | forest edge | 5 | 21 | 4/5 | 6/12 | 16 | 0.8 | Woodlot 2007b |
| 2006 | Sheffield | VT | Sheffield | forest edge | 8 | 38 | 4/24 | 6/13 | 840 | 22.1 | Woodlot 2006b |
| 2006 | Sheffield | VT | Sheffield | forest edge | 9 | 37 | 4/24 | 6/13 | 90 | 2.4 | Woodlot 2006b |
| 2006 | Sheffield | VT | Sheffield | forest edge | 8 | 34 | 4/24 | 6/13 | 178 | 5.2 | Woodlot 2006b |
| 2006 | Deerfield | VT | Searsburg | forest edge | 2 | 37 | 4/14 | 6/11 | 4 | 0.1 | Woodlot 2006e |
| 2008 | Rollins | ME | Lincoln | forest edge | 3 | 21 | 4/23 | 5/22 | 34 | 1.6 | Stantec 2008a |
| 2008 | Rollins | ME | Lincoln | forest edge | 3 | 29 | 4/23 | 5/22 | 16 | 0.6 | Stantec 2008a |
| | | | | | | | | | | | |
| **Met tower detectors** | | | | | | | | | | | |
| 2005 | Clayton | NY | Clayton | forest edge | 20 | 42 | 4/20 | 5/31 | 55 | 1.3 | Woodlot 2005b |
| 2005 | Clayton | NY | Clayton | forest edge | 15 | 36 | 4/20 | 5/31 | 12 | 0.3 | Woodlot 2005b |
| 2005 | Cohocton | NY | Cohocton | field | 30 | 29 | 5/2 | 5/30 | 21 | 0.7 | Woodlot 2006i |
| 2005 | High Sheldon | NY | Sheldon | field | 30 | 36 | 4/21 | 5/30 | 6 | 0.17 | Woodlot 2006a |
| 2005 | Jordanville | NY | Jordanville | field | 30 | 29 | 4/14 | 5/13 | 15 | 0.5 | Woodlot 2005f |
| 2005 | Liberty Gap | WV | Harper | forest edge | 30 | 21 | 4/17 | 6/7 | 2 | 0.1 | Woodlot 2005h |
| 2005 | Liberty Gap | WV | Harper | forest edge | 15 | 21 | 4/17 | 6/7 | 19 | 0.9 | Woodlot 2005h |
| 2005 | Marble River | NY | Churubusco | field | 30 | 46 | 4/14 | 5/30 | 12 | 0.3 | Woodlot 2005a |
| 2005 | Prattsburgh | NY | Prattsburgh | field | 30 | 17 | 4/15 | 5/10 | 8 | 0.5 | Woodlot 2005c |
| 2005 | Prattsburgh | NY | Prattsburgh | field | 15 | 20 | 4/11 | 5/30 | 8 | 0.4 | Woodlot 2005c |
| 2005 | Sheffield | VT | Sheffield | forest edge | 20 | 31 | 5/1 | 5/31 | 6 | 0.17 | Woodlot 2006b |
| 2005 | Stamford/Moresville | NY | Stamford | forest edge | 30 | 27 | 4/12 | 5/8 | 8 | 0.3 | Woodlot 2007a |
| 2005 | West Hill/Munnsville | NY | Munnsville | field | 30 | 22 | 5/10 | 5/31 | 6 | 0.3 | Woodlot 2005d |
| 2006 | Chateaugay | NY | Chateaugay | field | 40 | 54 | 4/16 | 6/8 | 117 | 2.2 | Woodlot 2006c |
| 2006 | Chateaugay | NY | Chateaugay | field | 20 | 54 | 4/16 | 6/8 | 103 | 1.9 | Woodlot 2006c |
| 2006 | Brandon | NY | Brandon | field | 15 | 38 | 4/7 | 6/4 | 848 | 22.3 | Woodlot 2006c |
| 2006 | Brandon | NY | Brandon | field | 30 | 36 | 4/7 | 6/4 | 114 | 3.2 | Woodlot 2006c |
| 2006 | Deerfield | VT | Searsburg | forest edge | 35 | 60 | 4/14 | 6/13 | 4 | 0.1 | Woodlot 2006e |
| 2006 | Deerfield | VT | Searsburg | forest edge | 15 | 47 | 4/14 | 5/31 | 0 | 0 | Woodlot 2006e |
| 2006 | Deerfield | VT | Searsburg | forest edge | 30 | 29 | 4/14 | 5/20 | 0 | 0 | Woodlot 2006e |
| 2006 | Deerfield | VT | Searsburg | forest edge | 15 | 21 | 4/14 | 5/16 | 7 | 0.3 | Woodlot 2006e |
| 2006 | Howard | NY | Howard | field | 50 | 36 | 4/15 | 6/4 | 5 | 0.1 | Woodlot 2006d |
| 2006 | Howard | NY | Howard | field | 20 | 45 | 4/15 | 6/7 | 16 | 0.4 | Woodlot 2006d |
| 2006 | Kibby | ME | Eustis | forest edge | 50 | 14 | 5/4 | 6/19 | 0 | 0 | Woodlot 2006f |
| 2006 | Kibby | ME | Eustis | forest edge | 50 | 24 | 5/4 | 6/19 | 0 | 0 | Woodlot 2006f |
| 2006 | Kibby | ME | Eustis | forest edge | 20 | 35 | 5/4 | 6/19 | 31 | 0.7 | Woodlot 2006f |
| 2006 | Kibby | ME | Eustis | forest edge | 50 | 35 | 5/4 | 6/19 | 0 | 0 | Woodlot 2006f |
| 2006 | Lempster | NH | Lempster | forest edge | 40 | 60 | 4/5 | 6/12 | 7 | 0.1 | Woodlot 2007b |
| 2006 | Lempster | NH | Lempster | forest edge | 20 | 50 | 4/5 | 6/12 | 3 | 0.1 | Woodlot 2007b |
| 2006 | Sheffield | VT | Sheffield | forest edge | 31 | 36 | 4/24 | 6/13 | 5 | 0.14 | Woodlot 2006b |
| 2007 | Stetson | ME | Stetson | forest edge | 30 | 47 | 4/24 | 6/18 | 52 | 1.1 | Woodlot 2007a |
| 2007 | Stetson | ME | Stetson | forest edge | 30 | 56 | 4/24 | 6/18 | 235 | 4.2 | Woodlot 2007a |
| 2007 | Stetson | ME | Stetson | forest edge | 30 | 56 | 4/24 | 6/18 | 36 | 0.6 | Woodlot 2007a |
| 2008 | Rollins | ME | Lincoln | forest edge | 40 | 52 | 4/23 | 6/13 | 29 | 0.6 | Stantec 2008a |
| 2008 | Rollins | ME | Lincoln | forest edge | 20 | 23 | 4/23 | 6/13 | 40 | 1.7 | Stantec 2008a |
| 2008 | Rollins | ME | Lincoln | forest edge | 40 | 23 | 5/22 | 6/14 | 3 | 0.1 | Stantec 2008a |
| 2008 | Rollins | ME | Lincoln | forest edge | 20 | 23 | 5/22 | 6/14 | 3 | 0.1 | Stantec 2008a |
| 2008 | Rollins | ME | Lincoln | forest edge | 40 | 53 | 4/23 | 6/13 | 166 | 3.1 | Stantec 2008a |
| 2008 | Rollins | ME | Lincoln | forest edge | 20 | 53 | 4/23 | 6/13 | 106 | 2.0 | Stantec 2008a |

# Appendix C

Raptor Survey Results

**Appendix C Table 1.** Species composition of raptors observed during raptor surveys

| **Species** | **4/25** | **5/1** | **5/2** | **5/7** | **5/9** | **5/10** | **5/13** | **5/14** | **5/20** | **5/23** | **5/29** | **5/30** | **Entire Season** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| american kestrel | | | 1 | | 1 | | | | | | | | 2 |
| bald eagle | | | | | | | | 1 | | | | | 1 |
| broad-winged hawk | 2 | | 1 | 1 | | 1 | 2 | 1 | 1 | | | 2 | 11 |
| osprey | | | | 1 | | | | | 1 | | | | 2 |
| red-tailed hawk | | | 1 | 1 | 2 | | 3 | | | | 1 | | 8 |
| sharp-shinned hawk | | | | 2 | | | | 1 | | | | | 3 |
| turkey vulture | 4 | 3 | 3 | 1 | 4 | 2 | 2 | 3 | | 1 | 3 | 3 | 29 |
| unknown buteo | | | | | | | | 1 | 1 | | | | 2 |
| **Daily Totals** | **6** | **3** | **6** | **6** | **7** | **3** | **7** | **7** | **3** | **1** | **4** | **5** | **58** |
| **Hours of Observation** | **7** | **7** | **7** | **7** | **7** | **7** | **7** | **7** | **7** | **2** | **7** | **7** | **79** |
| **Daily Passage Rate** | **0.86** | **0.43** | **0.86** | **0.86** | **1.00** | **0.43** | **1.00** | **1.00** | **0.43** | **0.50** | **0.57** | **0.71** | **0.73** |

**Appendix C Table 2.** Observation totals of raptors by hour

| Species | 08:00-09:00 | 09:00-10:00 | 10:00-11:00 | 11:00-12:00 | 12:00-13:00 | 13:00-14:00 | 14:00-15:00 | 15:00-16:00 | 16:00-17:00 | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|
| american kestrel | 1 | | | | | | | 1 | | 2 |
| bald eagle | | | | | | 1 | | | | 1 |
| broad-winged hawk | 4 | | | 3 | 1 | | | | 3 | 11 |
| osprey | | | 1 | | | 1 | | | | 2 |
| red-tailed hawk | | | | | 2 | 2 | 2 | 1 | 1 | 8 |
| sharp-shinned hawk | | | 1 | | 2 | | | | | 3 |
| turkey vulture | 2 | 4 | 4 | 7 | 3 | 5 | 2 | 2 | | 29 |
| unknown buteo | | | | | 1 | | | 1 | | 2 |
| **Hourly Totals** | 7 | 4 | 6 | 10 | 9 | 9 | 4 | 5 | 4 | 58 |

| **Appendix C Table 3.** Raptor flight altitudes by species | | | | |
|---|---|---|---|---|
| **Species** | **120 m or greater** | **less than 120 m** | **Outside 1 km** | **Entire Season** |
| american kestrel | | | 2 | 2 |
| bald eagle | 1 | | | 1 |
| broad-winged hawk | 2 | 5 | 4 | 11 |
| osprey | | 2 | | 2 |
| red-tailed hawk | 6 | 2 | | 8 |
| sharp-shinned hawk | | 3 | | 3 |
| turkey vulture | 2 | 25 | 2 | 29 |
| unidentified buteo | 1 | | 1 | 2 |
| **Entire Season** | **12** | **37** | **9** | **58** |

**Appendix C Table 4. Summary of Regional Spring 2008 Migration Surveys***

| | Location | Observation Hours | BV | TV | OS | BE | NH | SS | CH | NG | RS | BW | RT | RL | GE | AK | PG | ML | UA | UB | UE | UF | UR | MK | TOTAL | Birds/ hr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bradbury Mountain, Maine | 118 | 0 | 0 | 71 | 28 | 24 | 337 | 1 | 1 | 1 | 534 | 8 | 1 | 0 | 49 | 2 | 42 | 1 | 0 | 0 | 0 | 4 | 0 | 1,104 | 9.35 |
| | Barre Falls, MA | 20.5 | 0 | 3 | 10 | 2 | 0 | 14 | 1 | 0 | 0 | 46 | 4 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 90 | 4.39 |
| | Hawk Mountain, PA | 67 | 3 | 0 | 22 | 14 | 6 | 15 | 5 | 0 | 3 | 25 | 16 | 0 | 0 | 2 | 0 | 2 | 4 | 2 | 2 | 0 | 18 | 0 | 139 | 2.07 |
| | ***Oakfield, ME*** | *79* | *0* | *29* | *2* | *1* | *0* | *3* | *0* | *0* | *0* | *11* | *8* | *0* | *0* | *2* | *0* | *0* | *0* | *1* | *1* | *0* | *2* | *0* | *58* | *1.12* |

* Data obtained from hawkcount.org.

**Abbreviation Key:**

BV - Black Vulture
TV - Turkey Vulture
OS - Osprey
BE - Bald Eagle
NH - Northern Harrier
SS - Sharp-shinned Hawk
CH - Cooper's Hawk
NG - Northern Goshawk
RS - Red-shouldered Hawk
BW - Broad-winged Hawk
RT - Red-tailed Hawk
RL - Rough-legged Hawk
GE - Golden Eagle
AK - American Kestrel
ML - Merlin
PG - Peregrine Falcon
SW - Swainson's Hawk
UR - unidentified Raptor
UB - unidentified Buteo
UA - unidentified Accipiter
UF - unidentified Falcon
UE - unidentified Eagle
MK - Mississippi kite

**Appendix C Table 5.** Summary of other publicly available spring raptor survey results at other proposed wind facilities

| Project site | Date | Survey Days | Obs. Hours | Habitat type | Number of Raptors | Number of Species Observed | Raptors/Obs. hour | Range in Daily Passage Rates | % below (reported turbine height ) |
|---|---|---|---|---|---|---|---|---|---|
| **Spring 2005** | | | | | | | | | |
| Sheffield, Caledonia Cty, VT | April - May | 10 | 60 | Forested ridge | 98 | 10 | 1.63 | n/a | (125 m) 69% |
| Deerfield, Bennington Cty, VT (Existing facility) | April 9 - April 29 | 7 | 42 | Forested ridge | 44 | 11 (for both sites combined) | 1.05 | n/a | (125 m) 83% (at both sites combined) |
| Deerfield, Bennington Cty, VT (Western expansion) | April 9 - April 29 | 7 | 42 | Forested ridge | 38 | 11 (for both sites combined) | 0.9 | n/a | (125 m) 83% (at both sites combined) |
| **Spring 2006** | | | | | | | | | |
| Lempster, Sullivan Cty, NH | Spring 2006 | 10 | 78 | Forested ridge | 102 | n/a | 1.3 | n/a | (125 m) 18% |
| Mars Hill, Aroostook Cty, ME | April 12 - May 18 | 10 | 60.25 | Forested ridge | 64 | 9 | 1.06 | 0-5.04 | (120 m) 48% |
| **Spring 2007** | | | | | | | | | |
| Stetson Mountain, Washington Cty, ME | April 26 – May 4 | 9 | 58.75 | Forested ridge | 34 | 10 | .6 | n/a | (125 m) 65% |
| **Spring 2008** | | | | | | | | | |
| Rollins Mountain, Penobscot Cty, ME | Apr 3 to Jun 3 | 15 | 108 | Forested ridge | 122 | 12 | 1.1 | n/a | (125 m) 76% |

# Appendix 7-6
# Fall 2008 Bird Migration Survey Report for the Oakfield Wind Project
# Oakfield, Maine

# Fall 2008 Bird Migration Survey Report

## Radar and Visual Surveys
## for the Oakfield Wind Project in Oakfield, Maine

Prepared for

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Prepared by

Stantec Consulting
30 Park Drive
Topsham, ME  04086

**January 2009**

# Executive Summary

During fall 2008, Stantec Consulting (Stantec) conducted field surveys of bird migration activity at the Oakfield wind project area in Oakfield, Maine. The surveys are part of the planning process by First Wind Energy, LLC (First Wind) for a proposed wind project (Project). These surveys represented the third season of investigations undertaken at this site. The results of the field surveys provide useful information about site-specific migration activity and patterns in the vicinity of the Project area, including species composition and timing.

*Nocturnal Radar Survey*

The fall 2008 field survey targeted 20 nights of nocturnal radar sampling between late August and mid October. Surveys were conducted using X-band radar, sampling from sunset to sunrise. Each hour of sampling included the recording of radar video files during horizontal and vertical operation. The radar location at the summit of Sam Drew Mountain, the highest point within the Project area, allowed for unobstructed views nearly 360 degrees around the radar. The topography and tree height at this location also allowed for some limited views to the east/southeast below the height of the radar in the valley below.

The overall passage rate for the entire survey period was 501 targets per kilometer per hour (t/km/hr) with single nightly passage rates varying from 116 t/km/hr to 945 t/km/hr. Mean flight direction through the Project area was 200º ± 75º.

The mean flight height of targets was 309 meters (m) (1012 feet ['']) above the radar site. The average nightly flight height ranged from 172 m (565') to 552 m (1810'). The percent of targets observed flying below 120 m (394'), the maximum projected height of the proposed turbines, was 18 percent.

The mean flight direction, qualitative analysis of the surrounding topography and landscape, and mean flight altitude of targets passing over the Project area together indicate that avian migration in this area involves a broad front type of landscape movement, rather than a concentration or funneling of flight movements over or through any particular part of the Project area. This type of broad front movement, particularly in conjunction with the high flight heights, demonstrates a limited avian mortality risk during fall migration. Additionally, the flight height of targets indicates that the vast majority of bird migration in the area occurs well above the height of the proposed wind turbines.

*Diurnal Raptor Survey*

In addition to the nocturnal radar surveys, a total of 12 days of diurnal raptor surveys (84 hours of observation) were conducted from an observation point at the summit of Sam Drew Mountain. Surveys were conducted generally between 9:00 am and 4:00 pm on days with weather

conditions favorable for migration. A total of eight species, including 60 individual birds, were seen, with an overall passage rate of 0.7 raptors per observation-hour. The flight heights of raptors within the Project area indicate that 67 percent of the observations occurred below 120 m above the ground; however only 26 percent of total flight positions were over Sam Drew Mountain. Differences between species were observed and are likely due to typical flight height preferences, species behavior, or to limitations in the distance that different species are visible.

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PN195600152

# 1.0 Introduction

This report has been prepared to document and discuss observed avian activity patterns and species composition within the proposed Oakfield wind project area (Project) during the fall 2008 migration period.

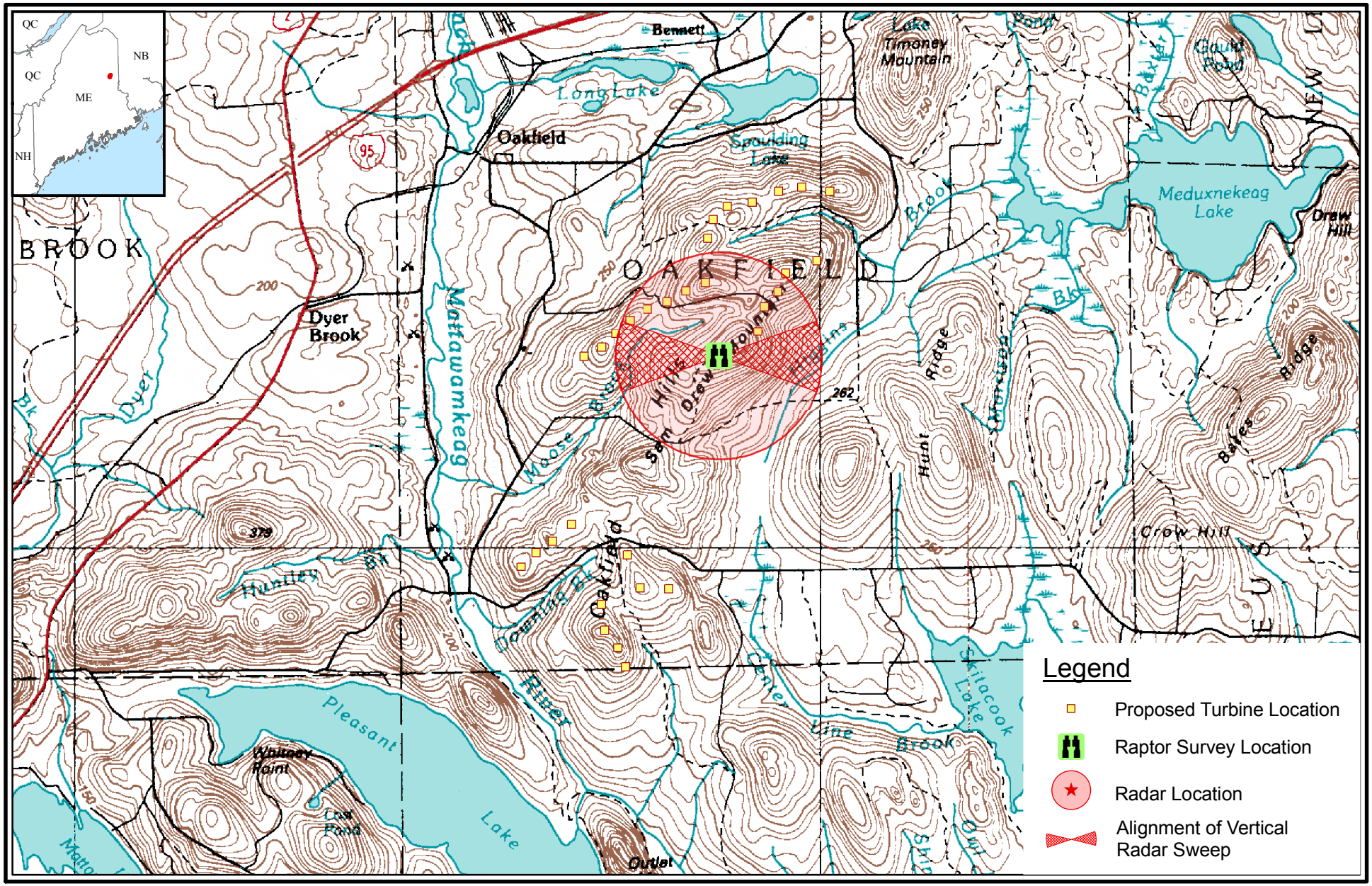
In advance of permitting activities for this Project, First Wind Energy, LLC (First Wind) contracted Stantec Consulting (Stantec) to conduct avian and bat surveys to determine the presence and, when possible, species composition of birds and bats in the Project area. The scope of these surveys was based on a combination of standard methods that are developing within the wind power industry for pre-construction surveys and is consistent with a number of other studies conducted recently in Maine and throughout the Northeast region of the United States.

## 1.1 SURVEY OVERVIEW

Following similar efforts in spring 2008, Stantec conducted field surveys for bird migration during fall 2008. The overall goals of the investigations were to document:

- passage rates for nocturnal migration in the vicinity of the Project area, including the number of migrants, their flight direction, and their flight altitude; and
- passage rates and species composition of raptors migrating through the Project area.

The following sections outline the survey methodology and results contributing toward the achievement of survey goals. Discussion of survey results and subsequent conclusions follow each section.




Prepared By:

Stantec

195600152-F101-SurveyLocation.mxd

Sheet Title:

*Project and Survey Location Map - Fall 2008*

Project:

*Oakfield Wind Project*
*Oakfield, Maine*

0 6,000
Feet

Date: Nov. 24, 2008

Scale: 1" = 6000'

Proj. No.: 195600152

Figure:

1.1

# 2.0 Nocturnal Radar Survey

## 2.1 INTRODUCTION

The majority of North American passerines migrate at night. The strategy to migrate at night may have evolved to take advantage of more stable atmospheric conditions for flapping flight (Kerlinger 1995). Additionally, night migration may provide a more efficient medium to regulate body temperature during active, flapping flight and could reduce the potential for predation while in flight (Alerstam 1990, Kerlinger 1995). Conversely, species, such as raptors, that use soaring flight migrate during the day to take advantage of warm rising air in thermals and laminar flow of air over the landscape, which can create updrafts along hillsides and ridgelines. Whereas raptor migration can be documented by visual daytime surveys, documenting the patterns of nocturnally migrating birds requires the use of radar or other non-visual technologies. Nocturnal radar surveys were conducted in the Project area to characterize fall nocturnal migration patterns.

## 2.2 METHODS

Marine surveillance radar, similar to that described by Cooper *et al.* (1991), was used during field data collection. The radar has a peak power output of 12 kilowatts (kW) and has the ability to track small animals, including birds, bats, and even insects, based on settings selected for the radar functions. It cannot, however, readily distinguish between different types of animals being detected. Consequently, all animals observed on the radar screen were identified as "targets." The radar has an "echo trail" function which captures past echoes of flight trails, enabling determination of flight direction. During all operations, the radar's echo trail was set to 30 seconds. The radar was equipped with a 2 m (6.5') waveguide antenna. The antenna has a vertical beam height of 20º (10º above and below horizontal), and the front end of the antenna was inclined approximately 5º to increase the proportion of the beam directed into the sky. Objects on the ground detected by the radar cause returns on the radar screen (echoes) that appear as blotches called ground clutter. Large amounts of ground clutter reduce the ability of the radar to track birds and bats flying over those areas. However, vegetation and hilltops near the radar can be used to reduce or eliminate ground clutter by "hiding" clutter-causing objects from the radar. These nearby features also cause ground clutter, but their proximity to the radar antenna generally limits the ground clutter to the center of the radar screen (Figure 2-1). The presence or reduction of potential clutter producing objects was carefully considered during site selection and radar station configuration.

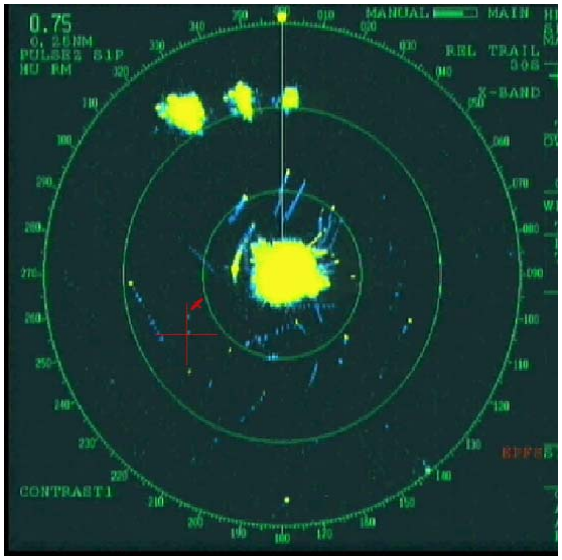



**Figure 2-1.** Ground clutter in Project area

The radar study was conducted from the summit of Sam Drew Mountain (Figure 1-1). Radar surveys were typically conducted from sunset to sunrise. Twenty nights of surveys were targeted between August 28 and October 11. Because the anti-rain function of the radar must be turned down to detect small songbirds and bats, surveys could not be conducted during periods of inclement weather. Therefore, surveys were planned largely for nights without rain. However, in order to characterize migration patterns during nights without optimal conditions, some nights with weather forecasts including occasional showers were sampled.

The radar was operated in two modes throughout the night. In surveillance mode, the antenna spins horizontally to survey the airspace around the radar and detects targets moving through the area. By analyzing the echo trail, the flight direction of targets can be determined. In vertical mode, the radar unit is tilted 90º to vertically survey the airspace above the radar (Harmata *et al.* 1999). In vertical mode, target echoes do not provide directional data, but do provide information on the altitude of targets passing through the vertical, 20º radar beam. Both modes of operation were used during each hour of sampling.

The radar was operated at a range of 1.4 km (0.75 nautical miles). At this range, the echoes of small birds can be easily detected, observed, and tracked. At greater ranges, larger birds can be detected, but the echoes of small birds are reduced in size and restricted to a smaller portion of the radar screen, thus limiting the ability to observe the movement pattern of individual targets.

### 2.2.1 Data Collection

The radar display was connected to the video recording software of a computer enabling digital archiving of the radar data for subsequent analysis. This software recorded and archived video samples continuously every hour from sunset to sunrise of each survey night. Alternating the radar antenna every ten minutes from vertical mode to horizontal mode, a total of 30 minutes of

vertical samples and 30 minutes of horizontal samples were collected within each hour. Video recordings were subsequently analyzed based on a random schedule for each night. During each hour, additional information was also recorded at the radar survey location including weather conditions, night vision device (NVD) observations, and ceilometer observations.

#### 2.2.1.1 Weather Data

Weather data was collected from an anemometer on the met tower at the summit of Sam Drew Mountain between August 28 and October 11. Additional data was also collected from an on-site weather station deployed at the radar location during this same timeframe. For reporting purposes, wind direction and wind speed was recorded by the anemometer on the met tower. Temperature was recorded by data loggers (HOBO Pro v2 U23-001, Onset Computer Corporation). The mean wind direction, wind speed, and temperature were calculated for each night.

NEXRAD weather radar images from the National Weather Service station in Houlton, Maine (selected for its proximity to the Project area and ability to provide adequate radar coverage) were examined on the dates surrounding the typical fall migration period (August 15 to October 15). NEXRAD radar provides a different type of data than the marine surveillance radar used on-site. This long-range Doppler radar produces reflectivity data on objects (and precipitation) in the sky, as well as the velocity of those objects. Because it covers such a large area, it does not track individual birds, but can be used to interpret large-scale bird migration patterns and the level of migration activity (Gauthreaux and Belser 1998). These radar images were then used to confirm that the nights selected for the on-site radar sampling period were representative of seasonal migration activity throughout the region.

#### 2.2.1.2 Night Vision Device Observations

A Night Vision Device (NVD) is an optical instrument that allows objects to be seen in near darkness by detecting ordinary ambient light, usually from the moon and stars, that is reflected by objects in the scene being viewed. NVDs contain an image intensifier tube that amplifies very weak light. A monocular NVD was used that was mounted on the user's head for hands-free use with a harness attachment (i.e., night-vision goggles). All potential targets (birds or bats), as well as insects observed with the NVD within the first five minutes of each hour for the first five hours of the survey period were recorded.

#### 2.2.1.3 Ceilometer Observations

Ceilometer surveys were conducted for five minutes following the completion of NVD surveys. Ceilometer surveys involved directing a one-million candlepower spotlight vertically into the sky in a manner similar to that described by Gauthreaux (1969). The ceilometer beam was monitored to document and characterize low-flying targets. The ceilometer was held in-hand so that any birds, bats, or insects passing through it could be tracked for several seconds, if needed. The number of birds, bats, and insects observed during each five minute survey period were recorded. The NVD and ceilometer observations provided an opportunity to document

birds and bats flying at low altitudes over the radar site and supplemented data collected by the radar unit.

### 2.2.2 Data Analysis

Video samples were analyzed using a digital analysis software tool developed by Stantec. For horizontal samples, targets (either birds or bats) were differentiated from insects based on their flight speed. Following adjustment for wind speed and direction, targets traveling faster than approximately 6 m (20') per second were identified as a bird or bat target (Larkin 1991, Bruderer and Boldt 2001). The software tool recorded the time, location, and flight vector for each target traveling fast enough to be a bird or bat within each horizontal sample, and these results were output to a spreadsheet. For vertical samples, the software tool recorded the entry point of targets passing through the vertical radar beam, the time, and flight altitude above the radar location, and then subsequently outputs the data to a spreadsheet. These datasets were then used to calculate passage rate (reported as targets per kilometer of migratory front per hour), flight direction, and flight altitude of targets.

Mean target flight directions (± 1 circular standard deviation) were summarized using software designed specifically to analyze directional data (Oriana2© Kovach Computing Services). The statistics used for this analysis are based on those used by Batschelet (1965), because they take into account the circular nature of the data. Nightly wind direction was also summarized using similar methods and data, which was collected from the nearest meteorological measurement tower (met tower) to the radar.

Flight altitude data were summarized using linear statistics. Mean flight altitudes (± 1 standard error [SE]) were calculated by hour, night, and overall season. The percent of targets flying below 120 meters, the approximate maximum height of the proposed wind turbines with blades, was also calculated hourly, for each night, and for the entire survey period.

#### 2.2.2.1 NEXRAD Radar Data Analysis

Nightly samples of reflectivity and velocity images were obtained from the National Oceanic and Atmosphere Administration (NOAA 2007) and visually assessed to determine the overall intensity of nightly migration. Each night was qualitatively categorized as: 1) no biological activity (very low activity or rainy nights); 2) light biological activity; or 3) moderate to heavy biological activity (Figure 2-2). These determinations were made based on the color-coded strength of the radar reflectance data, velocity and direction, and winds aloft data. The images selected for this assessment were generally timed to be from two to four hours after sunset. For data interpretation purposes, bird migration is discernable from most precipitation. Bird activity was detected on some nights when rain occurred periodically. On those nights, radar reflectivity patterns indicative of migrating birds were observed forming and then dissolving during those periods between rain events. Nights exhibiting these conditions were classified as having light migration activity.

Once NEXRAD images were analyzed, nights of on-site surveys in the Project area were compared with those same nights of NEXRAD data to confirm on-site sampling occurred during periods of moderate to heavy migration. The remainder of the nightly NEXRAD data was then summarized to identify the proportion of nights with moderate to heavy migration activity within the entire season as compared to nights sampled with on-site radar.

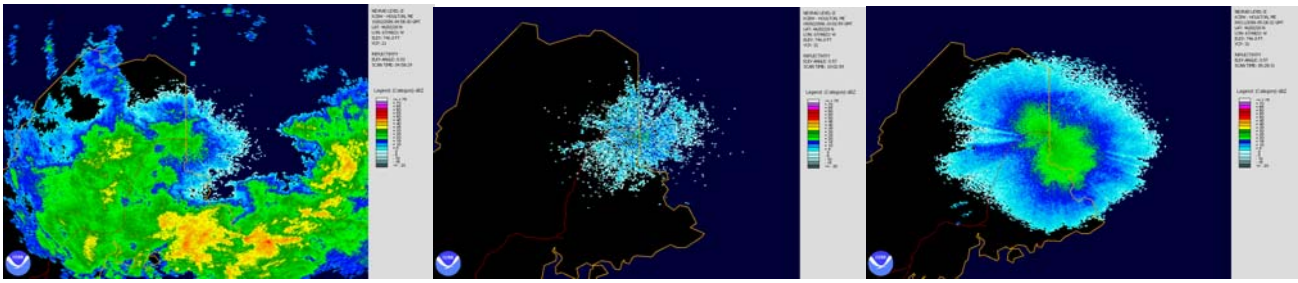


**Figure 2-2.** Examples of NEXRAD radar images depicting (from left to right) rain, light migration, and moderate to heavy migration activity.

## 2.3 RESULTS

Radar surveys were conducted during 20 nights from August 28 to October 11, 2008 (Appendix A, Table 1). Radar surveys were conducted from a 7m (23') tower next to the met tower at the summit of Sam Drew Mountain, the highest point within the Project area (Figure 1-1). At this location, the radar tower afforded relatively unobstructed 360 degree views, although some small areas to the northwest were slightly obstructed due to "ground clutter" caused from the detection of the tree tops on the nearby ridgeline. As a result, the radar was able to detect targets moving over the northwestern quadrant flying at radar level or higher over the northwestern valley. The steep topography to the east and lower tree height on that side of the met tower opening also allowed for the detection of targets flying below the height of the radar over the eastern valley.

### 2.3.1 Passage Rates

The overall passage rate for the entire survey period was 501 targets per kilometer per hour (t/km/hr); individual nightly passage rates varied from 116 t/km/hr on September 19 to 945 t/km/h on September 15 (Figure 2-3; also Appendix A, Table 1). Individual hourly passage rates ranged from 0 to 2550 t/km/hr during the survey period (Appendix A, Table 1). Hourly passage rates were typically highest two to three hours after sunset. For the entire season, passage rates peaked two hours after sunset and decreased consistently until sunrise (Figure 2-4).

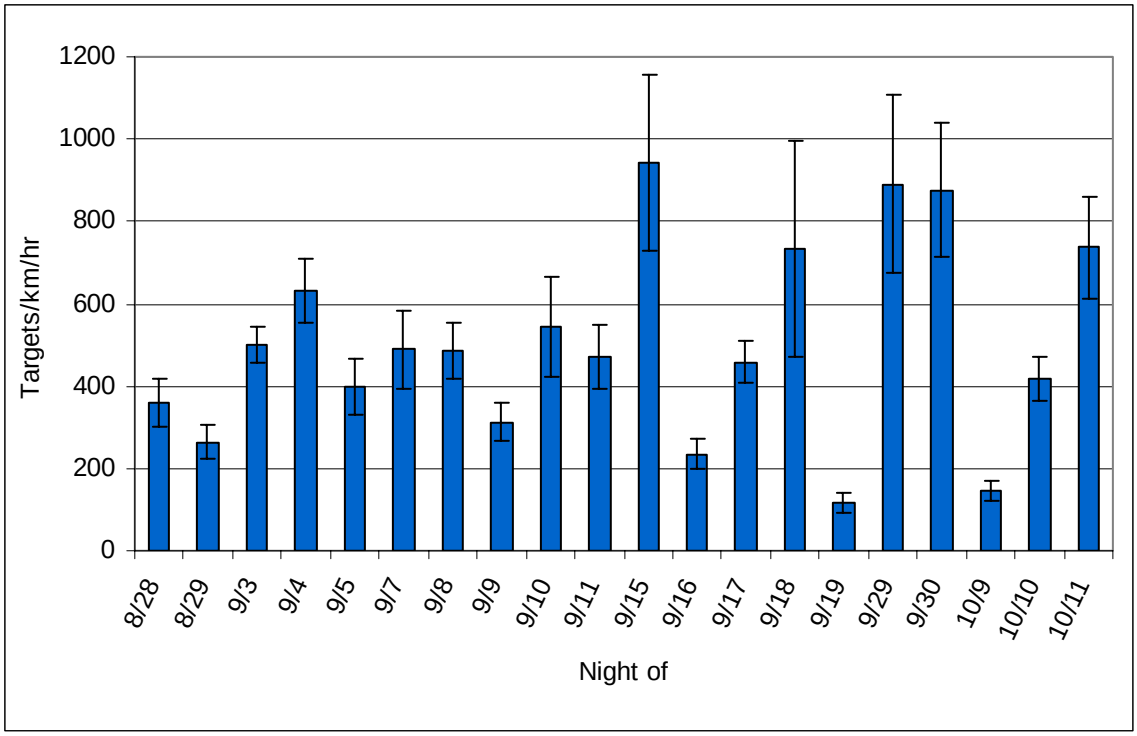



**Figure 2-3.** Nightly passage rates observed (error bars ± 1 SE)

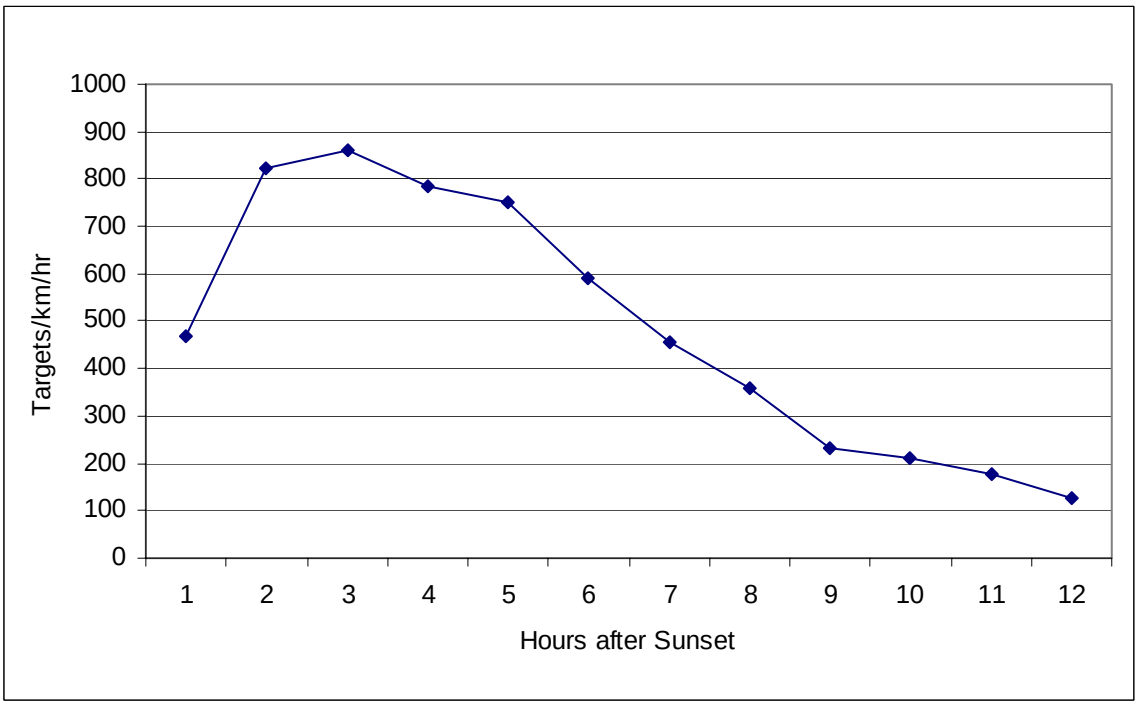



**Figure 2-4.** Hourly passage rates for entire season

### 2.3.2 Flight Direction

Mean flight direction through the Project area was 200° ± 75° (Figure 2-5). Although there was significant variation, most nights included movement generally to the south or southwest, as expected during fall migration periods (Appendix A, Table 2).

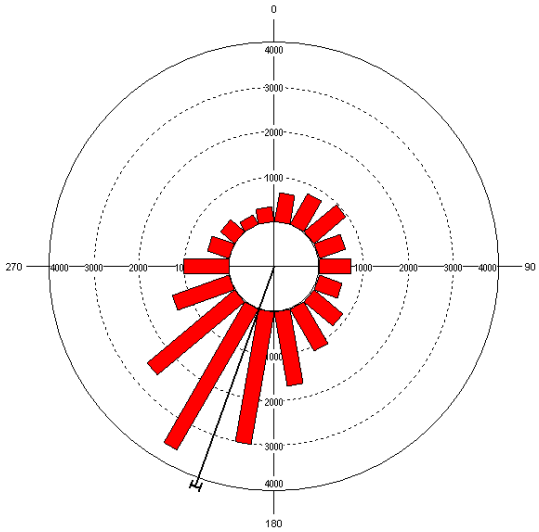



**Figure 2-5.** Mean flight direction for the entire season (the bracket along the margin of the histogram is the 95% confidence interval).

### 2.3.3 Flight Altitude

The seasonal average mean flight height of all targets was 309 m (1012‘) above the radar site. The average nightly flight height ranged from 172 m (565’) on September 8 to 552 (1810’) on September 29 (Figure 2-6; Appendix A, Table 3). The percent of targets observed flying below 120 m (394’), the maximum turbine height, was 18% (Figure 2-7). Flight heights were relatively consistent throughout the night (Figure 2-8).

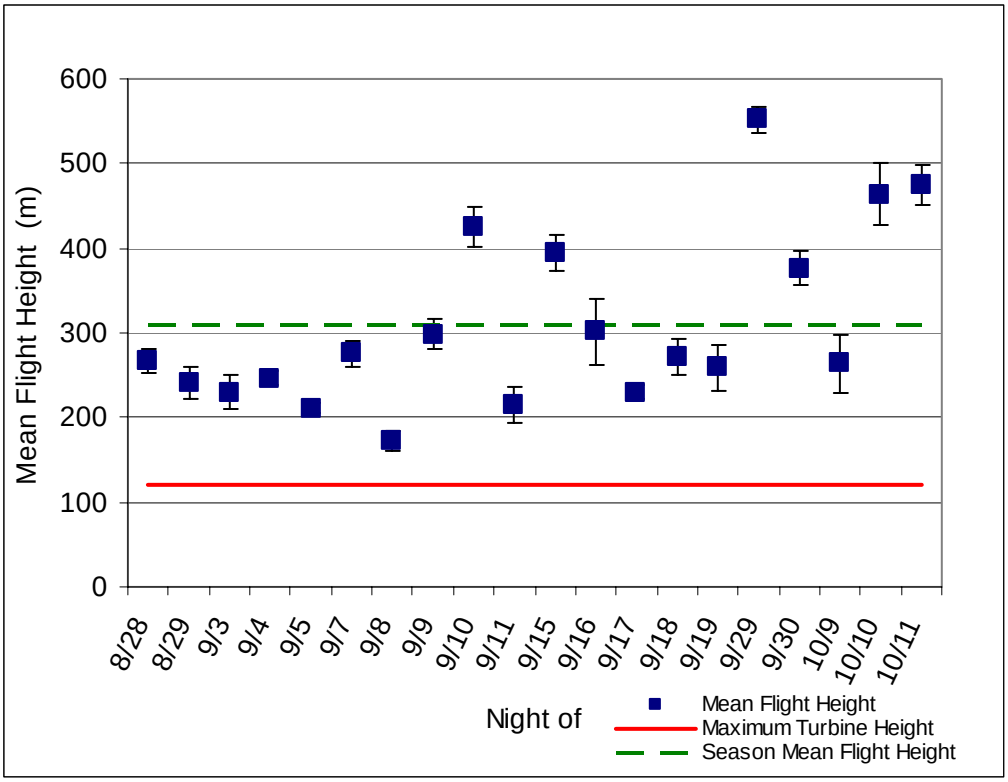



**Figure 2-6.** Mean nightly flight height of targets (error bars ± 1 SE)

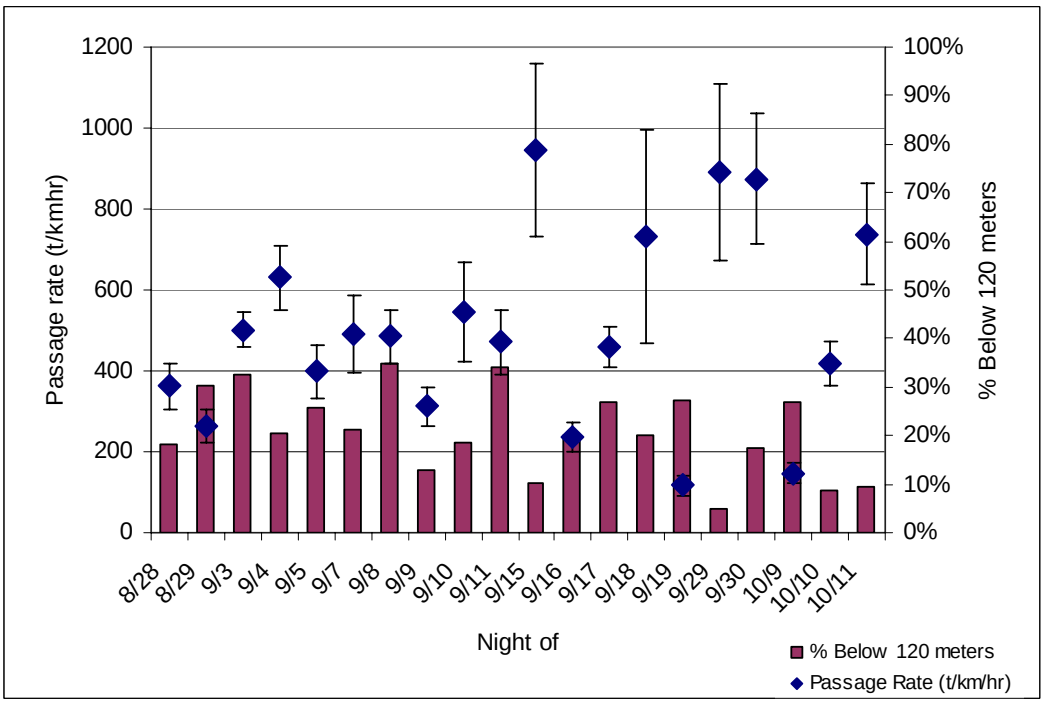



**Figure 2-7.** Percent of targets observed flying below a height of 120 m (394')

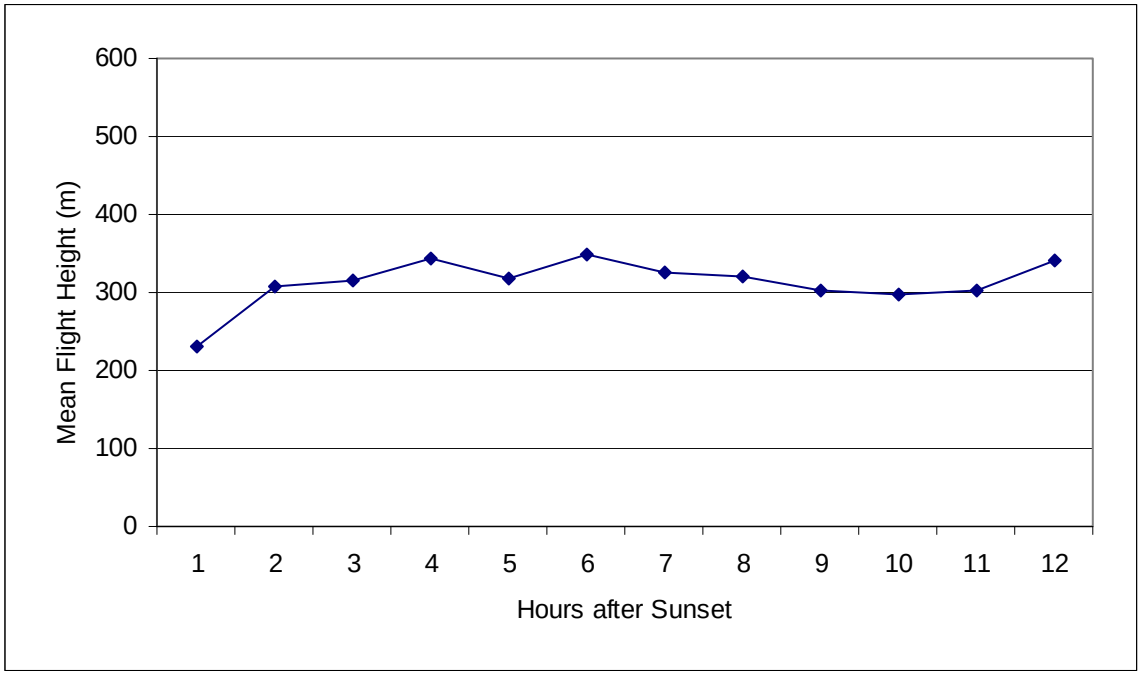



**Figure 2-8.** Hourly target flight height distribution

### 2.3.4 Weather Data Results

Mean nightly wind speeds in the Project area from August 28 to October 11 ranged between 0.35 and 15.75 meters per second (m/s). Mean nightly temperatures varied between 0.1 ºC and 19.9 ºC.

### 2.3.5 NEXRAD Analysis

A total of 62 nights of NEXRAD data were analyzed from August 15 to October 15, 2008, dates considered to be the typical fall migration period. Detectable biological activity occurred on 51 of those nights, with 10 nights of no detectable biological activity due to prolonged intense rain and 1 night where NEXRAD data was not available. There were 11 nights of light biological activity and 40 nights of moderate to heavy nights of biological activity. Moderate to heavy nights of biological activity indicated a distinct migration event was occurring, and were distinguished from nights of light activity when the type of biological activity was less distinct or apparent. Overall, NEXRAD data documented a greater proportion (65 percent) of nights with moderate to heavy biological activity. Likewise, during the 20 nights of on-site radar surveys, a greater proportion (65 percent) of sampling also occurred on nights with moderate to heavy biological activity (Table 2-1).

**Table 2-1.** Summary of NEXRAD and on-site radar data collection

| Migration Activity Category | Number of nights (NEXRAD) | Percent of Migration Nights | Number of nights with on-site radar | Percent of on-site radar data set |
|---|---|---|---|---|
| Rain | 10 | 16% | 2 | 10% |
| Light Migration | 11 | 18% | 5 | 25% |
| Moderate to Heavy Migration | 40 | 65% | 13 | 65% |
| Not Available | 1 | 1% | 0 | 0% |

### 2.3.6 Night-vision Device and Ceilometer Observations

Data collected during observations with a night-device and/or ceilometer yielded a total of 85 5-minute observations. Those observations included 627 targets (identified as bird or bat).

## 2.4 DISCUSSION

Considerable nightly variation in the magnitude and flight characteristics of nocturnally-migrating songbirds is typical and is often attributed to weather patterns, such as cold fronts and winds aloft (Hassler *et al.* 1963, Gauthreaux and Able 1970, Richardson 1972, Able 1973, Bingman *et al.* 1982, Gauthreaux 1991). Data from regional surveys using similar methods and equipment conducted within the last several years are rapidly becoming available, thus allowing an opportunity to compare the results from this area to other projects in the area. There are, however, limitations in comparing data from previous years with data from 2008, as year-to-year variation in continental bird populations may influence how many birds migrate through an area. Additionally, differences in site characteristics, particularly topography, local landscape conditions, and vegetation surrounding a radar survey location, can play a large role in any radar's ability to detect targets and the subsequent calculation of passage rate. These differences should be recognized as significant limiting factors in making direct site-to-site comparisons in passage rates.

Regardless of potential differences between radar survey locations, the nightly mean passage rates observed at the Project (498 t/km/hr) were within the upper range of other available studies that have been conducted to date within the local region (Appendix A, Table 5). There is currently no accurate quantitative method of directly correlating pre-construction passage rates at wind farms to operational impacts to birds and bats. Some research suggests that bird migration may be affected by landscape features, such as coastlines, large river valleys, and mountain ranges. This has been documented for diurnally migrating birds, such as raptors, but is not as well established for nocturnally migrating birds (Sielman *et al*. 1981; Bingman 1980;

Bingman *et al*. 1982; Bruderer and Jenni 1990; Richardson 1998; Fortin *et al*. 1999; Williams *et al.* 2001; Diehl *et al*. 2003). However, studies suggesting night-migrating birds are influenced by topography have typically been conducted in areas of steep topography, such as the most rugged areas of the northern Appalachians and the Alps.

An emerging body of studies characterizing nocturnal bird movements shows a relatively consistent pattern in flight altitude, with most birds' flight occurring at altitudes of several hundred meters or more above the ground. Comparison of radar-derived flight height between survey sites as measured by radar is generally less influenced by site characteristics than the calculation of passage rates, as the main portion of the radar beam is directed skyward, and the potential effects of surrounding vegetation on the radar's view can be more easily controlled. The range in mean flight heights is approximately 300 m (1,000') to 600 m (2,000') above the radar site. The percentage of targets documented at heights below the maximum turbine height is variable, but is typically within the range of 10 to 20 percent. The flight height documented in the Project area (309 m, 1012') is within the range of other studies in the region. While the observed percentage of targets flying below the maximum turbine height was relatively high (18%), it was also within the range of other local studies. The radar view in the Project area was also very good and included an easterly view shed that dropped approximately 122m (400') below the ridgeline elevation. Birds traveling thru the eastern valley would have been included in the radar viewshed and subsequently incorporated into the analysis.

### 2.5 CONCLUSIONS

Radar surveys during the fall 2008 migration period have provided important information on nocturnal bird migration patterns in the vicinity of the Project area. The results of the surveys indicate that bird migration patterns are generally similar to patterns observed at other sites in the northeastern U.S. region, especially other sites in Maine.

Migration activity varied throughout the season, which is not unexpected and is likely largely attributable to varying weather patterns. The mean passage rate is generally within the upper range of passage rates observed at other regional sites studied with similar methods and equipment. The combination of the flight height and flight direction data indicates that the majority of migrants are unimpeded by topography and flying in a broad-front flight pattern at significantly high elevations (relative to the proposed turbines and blade heights).

## 3.0 Diurnal Raptor Surveys

### 3.1 INTRODUCTION

The Project is located in the Laurentian Plains and Hills ecoregion of the "Eastern Continental Hawk Flyway[1]," which extends from the Canadian Maritimes south to eastern Florida. Within

[1] The Eastern Continental Flyway includes the Maritime Provinces; New England; New York (south and east of a line from Jamestown to Utica to the north end of Lake Champlain); Pennsylvania (all except Erie County); Mid-Atlantic

this large area, raptors tend to concentrate along linear ridges which, under certain atmospheric conditions, create deflective updrafts and thermals that raptors can use to fly long distances with minimal exertion. Glacial processes from the Laurentian ice shelf recession shaped the entire ecoregion, creating numerous lakes and wetland areas and carving out the gradual western slopes and steep eastern slopes of the Project area. The Project ranges in elevations from approximately 393 m (1290') at the peak of Sam Drew Mountain to approximately 162 m (530') at the East Branch of the Mattawamkeag River (Figure 1-1). The ridgeline on Sam Drew and Timoney Mountains are arranged in northeast to southwest linear fashion. Oakfield Hills is isolated from Sam Drew Mountain to the south by a valley saddle, but both share topographical similarities in the eastern and western slopes.

## 3.2 METHODS

### 3.2.1 Field Surveys

Raptor surveys were conducted during twelve days from late August to mid October from the radar tower next to the met tower at the summit of Sam Drew Mountain (Figure 1-1). The radar tower afforded views to the south, east and west. Views down into the valley to the northwest were obstructed due to the nature of the gradually sloping terrain and vegetation. However, the observer was able to see over the tops of surrounding trees to account for raptors flying at eye level or higher over the northwestern valley.

Raptor surveys were generally conducted on days with favorable flight conditions, which typically occur on days following the passage of weather fronts and low-pressure systems causing northerly winds. Surveys were based on Hawk Migration Association of North America (HMANA) methods (HMANA 2007). Surveys were conducted from 9 am to 4 pm, during the peak hours of thermal development and raptor movement. During surveys, observers scanned the sky and surrounding landscape for raptors with binoculars and a spotting scope. Observations were recorded onto HMANA data sheets, which summarize the data by hour. Hourly weather observations, including wind speed and direction, temperature, percent cloud cover, and precipitation were recorded. Information regarding the raptors' behavior and tendency to remain within the same location throughout the study period was noted in order to differentiate between migrating and resident birds. When possible, the general flight paths of observed individuals were plotted on topographic maps of the Project area.

Flight heights of birds were documented and categorized as less than, greater than, or equal to 120 m (394') above ground level (ground directly below the bird itself), which is the approximate height of the proposed wind turbines. Nearby objects with known heights, such as meteorological towers and nearby trees were used to gauge flight height.

States through Georgia, West Virginia, Kentucky and Tennessee; Florida east of a line from Lake Seminole south to Apalachicola (Kellogg 2007).

Flight positions were categorized into 4 categories: A) flight path directly over Sam Drew (A1-parallel, or A2-perpendicular to Sam Drew, or A3-within valley saddle between Sam Drew and Oakfield Hills), B) flight path over upper slope portions of Sam Drew, C) flight path over lower slope of Sam Drew, and D) flight path not within Project area; Figure 3-1).

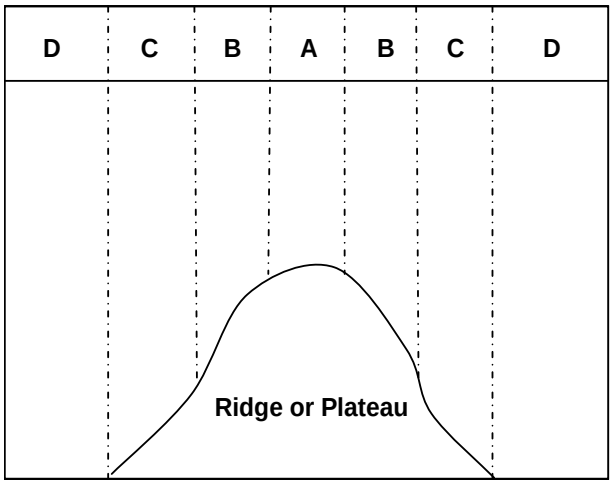



**Figure 3-1**. Flight position codes

Birds that flew too rapidly or were too far to accurately identify were recorded as unidentified to their genus or, if the identification of genus was not possible, unidentified raptor. Priority was given to raptor observations; however observers collected incidental data for other avian species observed including passerines and water birds.

### 3.2.2 Data Analysis

The raptor observation data was summarized by survey day and for the entire survey period. Analysis included a summary of:

- The total number of individuals per species observed for each survey day and for the entire survey period,
- The seasonal and daily observation rate (birds per hour). This was calculated for each survey day as well as for the entire fall survey period.
- The total number of individuals, by species, observed flying above or below 120 m (394') within the Project area; and
- The number of birds suspected to be resident based on their indirect flight paths and their tendency to occur in the Project area multiple times throughout the day.

The mapped flight paths and recorded flight positions were reviewed to identify any general flight patterns for migrant raptors in the vicinity of the Project area. In addition, minimum flight heights for individuals passing through each positional category were averaged.

Observations from the Project area were compared to 2008 data from local or regional HMANA hawk watch sites available on the HMANA web site or from HMANA yearly reports. Eight HMANA watch sites were used for comparison, including sites in Maine, New Hampshire, Massachusetts, Pennsylvania, and Quebec. Although migration is likely to vary with topography, location, season, and weather, all HMANA sites used for comparison are within the Eastern Continental Hawk Flyway region. Also provided for comparison, are the results of available regional surveys conducted at other proposed wind farms mainly located in New York, Vermont, New Hampshire, and Maine.

## 3.3 RESULTS

Most surveys were conducted on clear days allowing for optimal visibility. Surveys were conducted from August 26 to October 14, resulting in a total of 12 survey days. Temperatures ranged from 7.9° C (October 13) to 28° C (September 2) across the season. Winds speeds ranged from calm (September 11) to 26 kilometers per hour (August 26).

Surveys were conducted for a total of 84 hours during the 12 survey days and daily count totals ranged from to 0 raptors on October 9 to 17 raptors on September 30 (Figure 3-2). A total of 60 raptors representing 8 species[2] were observed during the survey period (Figure 3-3), yielding an overall observation rate of 0.7 birds/hour (Appendix B Table 1). Turkey vultures (*Cathartes aura)* were the most abundant species observed (n=27) and comprised approximately 50

[2] While turkey vultures are not phylogenetically considered true raptors, they are diurnal migrants that exhibit flight characteristics similar to *Buteos, Accipiters* and other *Falconiformes* species, therefore vultures are typically included during hawk watch surveys.

percent of all observations, followed by sharp-shinned hawk (*Accipiter striatus*) (n=8) and red-tailed hawk (*Buteo jamaicensis)* (n=8).

Observers detected 49 of 58 raptors on days with northerly or northwesterly winds, likely due to tailwinds and the deflective updrafts created when wind collides with the western slope of Sam Drew Mountain. In addition to varying ranges in daily counts due to seasonal variations, the timing of raptor observations varied during each survey day. The number of observations was relatively consistent throughout the day although a peak occurred between 1:00 pm and 3:00 pm (Figure 3-4, Appendix B Table 2).

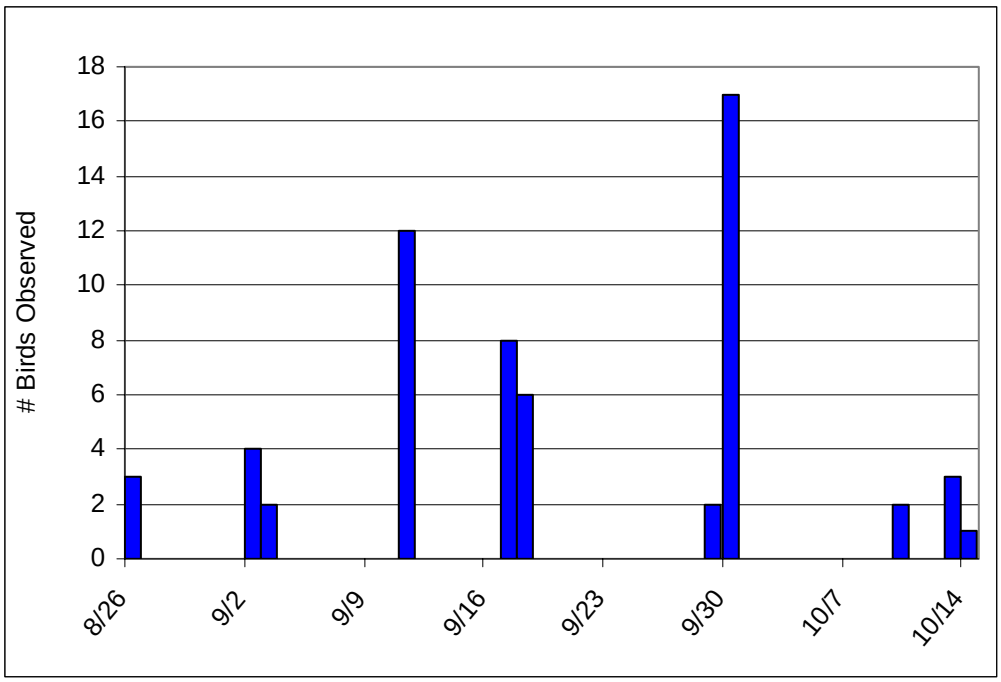



**Figure 3-2.** Total number of individuals observed per survey day

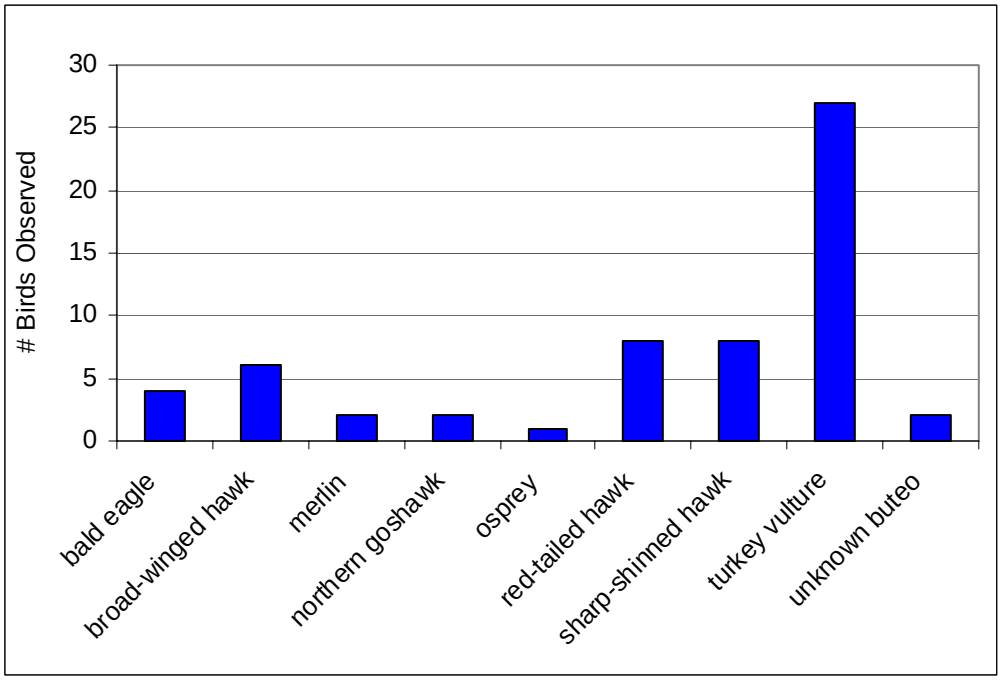



**Figure 3-3.** Number of individuals observed, by species

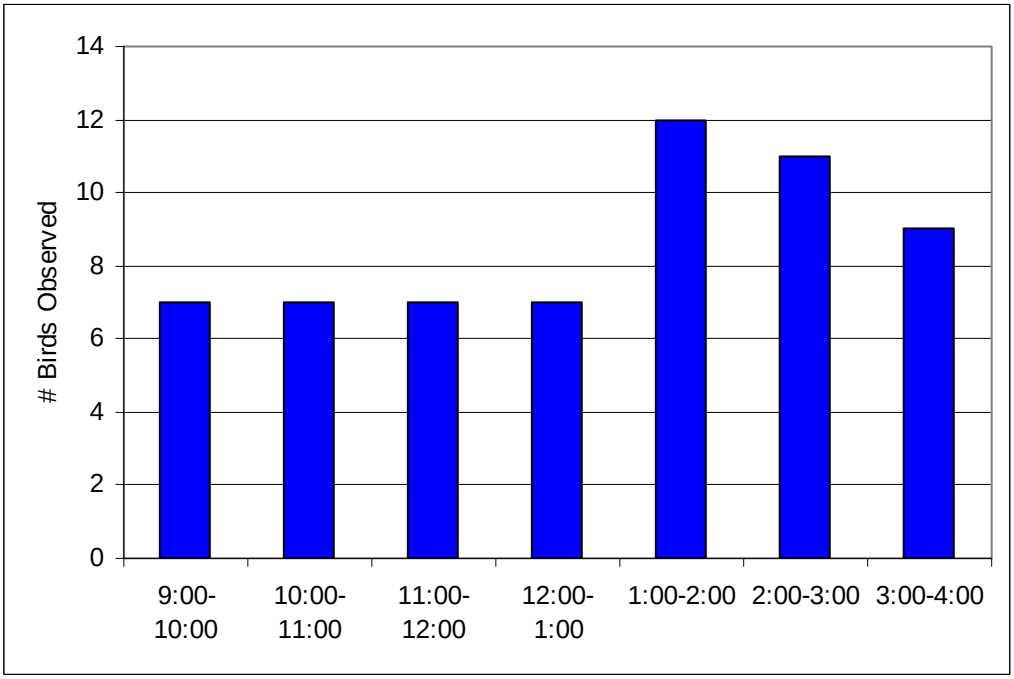



**Figure 3-4.** Number of individuals observed per survey hour

As raptors traveled through or in the vicinity of the Project area, they often occurred in multiple flight positions (A-D) along the ridge or outside of the Project area[3]. Of the 116 total recorded

[3] The result of which is a higher number of recorded flight positions (n=116) than individual bird observations (n=60).

flight positions, over a third of raptors (n=41; 35%) were observed flying directly over Sam Drew during some portion of their flight path (position A). Twenty-six percent (n=30) were observed flying along the upper slope or crest of the ridgeline (position B) and twenty-eight percent (n=33) were observed along the lower slope or crest of the ridgeline (position C) and ten percent (n=12) were observed flying outside the Project area (position D).

For those birds observed within 1km of the observation site, flight heights were categorized as below or above 120 m (394'), the approximate maximum height of the proposed turbines. Sixty-seven percent (n=36) of all raptors observed within the Project area were flying less than 120 m (304') above the ground for at least a portion of their flight through the Project area (Figure 3-5, Appendix B Table 3); however, only 26 percent (n=29) of raptor positions observed within Project area were flying directly over the ridge (position A) at a flight height under 120 m (Figure 3-5; Appendix B, Table 3).

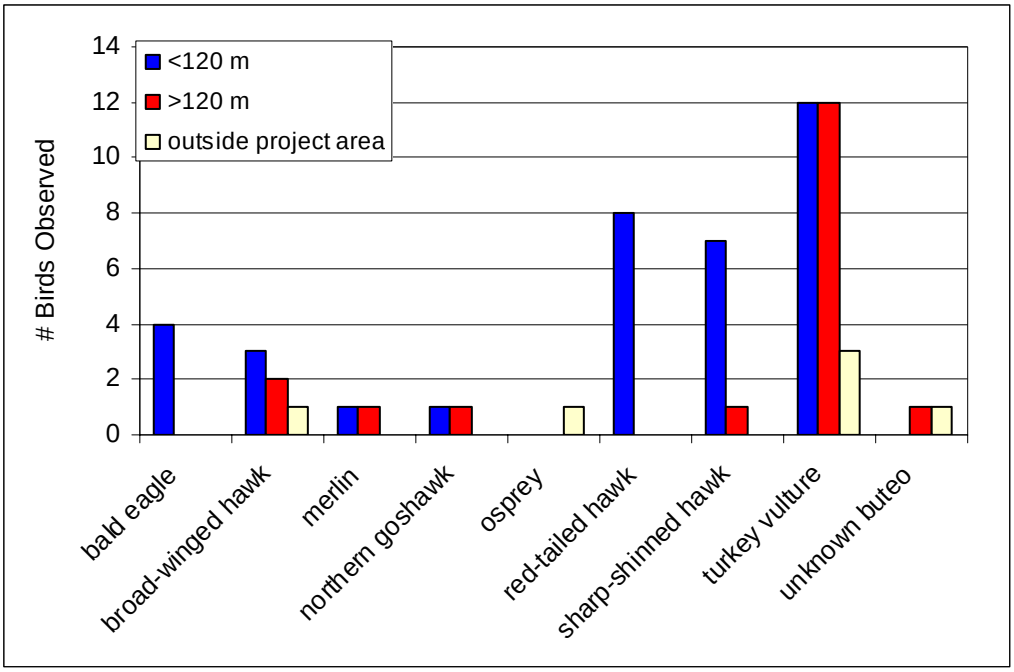



**Figure 3-5.** Raptor flight height distribution through the Project area

The average of the minimum recorded flight height was calculated for observations of birds within each flight category: for the 41 observations in position A, the average minimum flight height was 116 m (381'); for the 30 birds in position B, the average minimum flight height was 81 m (266'); for the 33 birds in position C, the average minimum flight height was 148 m (485'); and for the 12 birds seen in position D, the average minimum flight height was 177 m (581').

Four observations of Bald eagle *(Haliaeetus leucocephalus),* currently listed as a Threatened Species in Maine[4]; were documented on three days. No other state or federally listed endangered or threatened species were observed. MDIFW moderate priority listed species that were detected include broad-winged hawk (*Buteo platypterus*) (n=6), merlin (*Falco columbarius*) (n=2), and northern goshawk (Accipiter gentilis) (n=1).

*Incidental bird observations*

A total of 25 different species of birds were observed incidentally during the raptor surveys. Appendix B, Table 4 lists the different species observed.

## 3.4 DISCUSSION

The number of raptors observed in the Project area varied between survey dates and were influenced by varying wind direction, weather and raptor flight behavior.

Turkey vultures were the most commonly observed species. There were four observations of bald eagle, occurring on three separate dates; three of these were observed flying over the ridgeline below 120 m. Three moderate priority-listed species were also observed (broad-winged hawk, merlin, and northern goshawk). There were six observations of broad-winged hawk, primarily in early September along the upper or lower slopes of Sam Drew. There were also two observations of merlin, but there was no consistency between the flight locations or patterns between the two observations. Finally, there were three observations of northern goshawk soaring over the ridgeline. Only one northern goshawk was flying below 120 m.

The passage rate in the Project area for the fall 2008 survey period was 0.7 birds/hour. During the fall migration season at other Hawkwatch® sites in the region, seasonal passage rates varied from 10.9 raptors/observer hour (Cadillac Mountain, Maine) to 48.8 raptors/observer hour (Shatterack Mountain, Massachusetts) (Appendix B, Table 5). It's important to note Hawkwatch® sites are intentionally located at prominent topographical points that have been successfully used over time to document raptor passages, and which are commonly acknowledged as popular migratory routes along generally north to south orientated leading lines. Additionally, the HMANA survey methods differ to some extent from survey methods conducted at proposed wind sites in that 1) flight heights are not gauged during HMANA surveys, and 2) HMANA surveyors often do not count birds believed to be resident. These factors should be considered when making comparisons between sites.

Also available for comparison are the public results of fall surveys at other regionally proposed wind sites from 1999 to 2006. Seasonal passage rates among these sites ranged from 1.5 (Mars Hill, Maine; forested ridge) to 12.7 (Deerfield, Vermont, forested ridge) birds/hr (Appendix B, Table 6). Several wind sites in the region share topographical similarities to mountains in the Project area, and those results are all similar than those observed in the Project area (e.g., Stetson, Rollins, Mars Hill).

[4] In January 2009, the Commissioner of the Maine Department of Inland Fisheries and Wildlife (MDIFW) will be recommending removal of the Bald Eagle from Maine's list of Endangered and Threatened Species (MDIFW, 2008).

Flight heights of raptors observed in the Project area indicate that migrating raptors occur in the zone of the blade-swept area of the proposed turbines. Of the total number of individual raptors observed, 67 percent were observed below 120 m (394') for at least a portion of their flight through the Project area. Among the data available from proposed wind sites in the East, a general trend has been that the majority of raptors have been below the height of the proposed turbines (Appendix B, Table 6); the range of birds below the towers has been between 9 to 89 percent during fall migration. Variations in flight heights are due to the particular flight behaviors of different raptor species, as well as daily weather conditions. Typically, *accipiters* and falcons use up-drafts from side slopes to gain lift and, therefore, usually fly low over ridgelines. *Broad-winged hawks and sharp-shinned hawks* tend to use lift from strong thermals that develop in late summer and tend to fly high during hours of peak thermal development. Late season migrants, such as golden eagle and rough-legged hawk, utilize strong tailwinds and tend to slope soar more than early season migrants. Raptors (*accipiters* in particular) typically fly lower than usual during strong headwinds and higher during strong tailwinds (Bidlestein 2006, Kerlinger and Geautreaux 1985).

Observations of flight patterns indicated that Sam Drew Mountain serves as a leading local migrating line as a majority of raptors utilized updrafts and thermals above the ridgeline and upper slopes or crest of the ridgeline. Flight patterns revealed no preference between flying parallel or perpendicular to the ridgeline. No observations were made of raptors flying over the valley saddle between Sam Drew Mountain and Oakfield Hills.

Migration of raptors is a dynamic process due to various behavioral and environmental factors. As a result, flight pathways and movements along ridges, side slopes, and across valleys may vary seasonally, daily, or hourly. Raptors may shift and use different ridge lines and cross different valleys from year to year or season to season. Atmospheric conditions are major factors that influence migration pathways. The flight paths of raptors observed in the Project area varied between survey dates and were influenced by varying wind direction and weather. Wind strongly affects the propensity of raptors to concentrate along linear features (such as rivers, ridges, and coasts). The precise location of the migrants relative to a linear feature is what directs concentrations of migrating birds along linear features and can be related to lateral drift caused by crosswinds (Richardson 1998).

Although the greater occurrence of migrants at low altitudes increases the potential for migrating raptors to come into the vicinity of the proposed wind turbines, raptor mortality in the United States, outside of California, has been documented to be very low. For example, mortality rates found at onshore wind developments, outside of Altamont Pass in California, have documented 0 to 0.07 fatalities/turbine/year from 2000-2004 (GAO 2005). A more recent study at the Maple Ridge Wind Power facility in New York also documented very low raptor mortality. Only a single American kestrel was found, in a one year study covering 50 of 120 operational turbine sites (Jain *et al* 2007). Several other studies that have been recently conducted in the U.S have documented few raptor fatalities and few more than 20 fatalities have been reported at more than a dozen sites surveyed in recent years (Osborn *et al*. 2000, Johnson *et al*. 2002, Kerlinger 2002, Young *et al*. 2003, Erickson *et al*. 2000, Kerlinger 2006, Erickson *et al*. 2002, Johnson *et al*. 2003, Kerns and Kerlinger 2004, Arnett *et al*. 2005, Koford *et al*. 2005, Fiedler *et al*. 2007,

Jain *et al*. 2007, Jain et al. 2008). No raptor fatalities were documented at Mars Hill during any of the four migration surveys encompassed by the two years of monitoring. In fact, only one individual of one raptor species, a barred owl (*Strix varia*) was documented during the first survey period in 2008. This fatality was found between two turbines and, while it was attributed to a turbine strike, could have occurred due to the harsh 2007-2008 winter conditions that caused notable barred owl winter fatality in other areas of the state (Stantec, unpublished data).

Studies have documented high raptor collision avoidance behaviors at modern wind facilities (Whitfield and Madders 2006, Chamberlain *et al.* 2006). As most raptors are diurnal, raptors may be able to visually, as well as acoustically detect turbines during periods of fair weather. Foraging raptors that may become distracted by prey or migrant raptors flying during periods of reduced visibility may be at increased risk of collision with wind turbines.

## 3.5 CONCLUSIONS

Raptor passage rates observed at different sites in the region vary due to topography, location, season, weather, and visibility. The fall 2008 passage rate at Oakfield is low in comparison to other HMANA sites in the region during fall 2008, as well as in relation to those passage rates observed at other proposed wind farms in the region where visibility and topography are generally comparable.

Although 67 percent of observed flights in the Project area occurred below the maximum rotor-zone of the proposed turbines, only 26 percent were observed flying directly over the Project ridgeline. Despite the generally low observed flight heights of raptors (generally 9 to 89 percent of migrants occur below the rotor-zone at proposed wind farms in the region), raptors have demonstrated high turbine collision avoidance behaviors as well as relatively low collision mortality at existing wind farms.

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# Appendix A

Radar Survey Data Tables

**Appendix A Table 1. Survey dates, results, level of effort, and weather - Fall 2008**

| Date | Passage rate | Flight Direction | Flight Height (m) | % below 120 m | Hours of Survey | Temperature (c) | Wind Speed (m/s) | Wind Direction (from) |
|---|---|---|---|---|---|---|---|---|
| 8/28 | 362 | 255 | 267 | 18% | 10 | 13.5 | 9.4 | 62 |
| 8/29 | 264 | 91 | 240 | 30% | 11 | 13.9 | 5.0 | 244 |
| 9/3 | 502 | 341 | 230 | 33% | 11 | 15.3 | 5.6 | 191 |
| 9/4 | 631 | 199 | 247 | 20% | 11 | 11.8 | 6.5 | 359 |
| 9/5 | 399 | 27 | 210 | 26% | 11 | 16.5 | 9.4 | 206 |
| 9/7 | 490 | 166 | 275 | 21% | 11 | 10.5 | 9.9 | 294 |
| 9/8 | 485 | 79 | 172 | 35% | 11 | 13.7 | 7.8 | 249 |
| 9/9 | 312 | 164 | 299 | 13% | 12 | 9.2 | 10.4 | 308 |
| 9/10 | 546 | 193 | 425 | 18% | 11 | 6.2 | 8.6 | 319 |
| 9/11 | 471 | 122 | 214 | 34% | 10 | 10.3 | 5.8 | 247 |
| 9/15 | 945 | 189 | 395 | 10% | 12 | 8.4 | 9.5 | 325 |
| 9/16 | 236 | 92 | 302 | 20% | 12 | 9.1 | 7.6 | 264 |
| 9/17 | 458 | 46 | 230 | 27% | 10 | 9.0 | 9.0 | 313 |
| 9/18 | 732 | 214 | 272 | 20% | 11 | 2.0 | 8.2 | 356 |
| 9/19 | 116 | 217 | 260 | 27% | 11 | 4.6 | 10.8 | 209 |
| 9/29 | 891 | 247 | 552 | 5% | 12 | 8.6 | 7.1 | 351 |
| 9/30 | 875 | 275 | 377 | 18% | 12 | 9.7 | 4.8 | 139 |
| 10/9 | 147 | 117 | 264 | 27% | 12 | 9.7 | 10.0 | 271 |
| 10/10 | 418 | 176 | 464 | 9% | 12 | 5.7 | 10.3 | 302 |
| 10/11 | 738 | 207 | 475 | 10% | 12 | 4.3 | 9.5 | 333 |

**Appendix A Table 2. Summary of passage rates by hour, night, and for entire season.**

| Night of | Passage Rate (targets/km/hr) by hour after sunset | | | | | | | | | | | | Entire Night | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Mean | Stdev | SE |
| 8/28 | 457 | -- | 724 | 564 | 455 | 279 | 246 | 293 | 286 | 184 | 129 | -- | 362 | 185 | 58 |
| 8/29 | 314 | 450 | 279 | 493 | 321 | 271 | 214 | 150 | 133 | 236 | 43 | -- | 264 | 132 | 40 |
| 9/3 | 589 | 739 | 671 | 583 | 429 | 520 | 471 | 471 | 314 | 479 | 254 | -- | 502 | 143 | 43 |
| 9/4 | 305 | 757 | 911 | 900 | 846 | 750 | 681 | 743 | 482 | 463 | 96 | -- | 631 | 262 | 79 |
| 9/5 | 375 | 704 | 766 | 650 | 477 | 279 | 334 | 321 | 171 | 129 | 182 | -- | 399 | 222 | 67 |
| 9/7 | 461 | 1036 | 936 | 757 | 656 | 450 | 300 | 246 | 240 | 129 | 176 | -- | 490 | 314 | 95 |
| 9/8 | 554 | 771 | 868 | 643 | 586 | 429 | 402 | 321 | 196 | 171 | 394 | -- | 485 | 223 | 67 |
| 9/9 | 464 | 380 | 343 | 370 | 471 | 493 | 450 | 279 | 214 | 107 | 167 | 0 | 312 | 160 | 46 |
| 9/10 | 407 | 900 | 1029 | 1215 | 979 | 482 | 307 | 171 | 136 | 139 | 236 | -- | 546 | 405 | 122 |
| 9/11 | 249 | 895 | 600 | 531 | 705 | 716 | 286 | 289 | 230 | 209 | -- | -- | 471 | 249 | 79 |
| 9/15 | 1693 | 2374 | 1923 | 996 | 1339 | 879 | 607 | 571 | 272 | 364 | 286 | 32 | 945 | 741 | 214 |
| 9/16 | 145 | 314 | 450 | 395 | 300 | 328 | 236 | 204 | 179 | 120 | 129 | 29 | 236 | 124 | 36 |
| 9/17 | 382 | 582 | 658 | 493 | 497 | 643 | 546 | -- | -- | 307 | 257 | 214 | 458 | 159 | 50 |
| 9/18 | 552 | 2064 | 2550 | 1264 | 736 | -- | 407 | 171 | 107 | 71 | 114 | 14 | 732 | 868 | 262 |
| 9/19 | 161 | 266 | 167 | 186 | 146 | 116 | 96 | 54 | 39 | 27 | 21 | -- | 116 | 77 | 23 |
| 9/29 | 759 | 1329 | 1496 | 1950 | 2207 | 1371 | 657 | 403 | 164 | 176 | 73 | 107 | 891 | 755 | 218 |
| 9/30 | 591 | 938 | 1277 | 1634 | 1543 | 1420 | 1227 | 957 | 536 | 198 | 103 | 75 | 875 | 564 | 163 |
| 10/9 | 364 | 150 | 137 | 161 | 182 | 71 | 94 | 143 | 30 | 86 | 121 | 225 | 147 | 86 | 25 |
| 10/10 | 241 | 364 | 550 | 825 | 648 | 509 | 429 | 446 | 257 | 249 | 214 | 286 | 418 | 189 | 55 |
| 10/11 | 312 | 632 | 907 | 1080 | 1532 | 1254 | 1153 | 579 | 421 | 343 | 343 | 295 | 738 | 431 | 124 |
| **Entire Season** | **469** | **823** | **862** | **785** | **753** | **592** | **457** | **359** | **232** | **209** | **176** | **128** | **501** | **240** | **54** |

| Appendix A Table 3. Mean Nightly Flight Direction | | |
|---|---|---|
| **Night of** | **Mean Flight Direction** | **Circular Stdev** |
| 8/28 | 255 | 30 |
| 8/29 | 91 | 103 |
| 9/3 | 341 | 91 |
| 9/4 | 199 | 34 |
| 9/5 | 27 | 23 |
| 9/7 | 166 | 39 |
| 9/8 | 79 | 49 |
| 9/9 | 164 | 48 |
| 9/10 | 193 | 26 |
| 9/11 | 122 | 116 |
| 9/15 | 189 | 33 |
| 9/16 | 92 | 97 |
| 9/17 | 46 | 78 |
| 9/18 | 214 | 23 |
| 9/19 | 216 | 38 |
| 9/29 | 245 | 34 |
| 9/30 | 274 | 40 |
| 10/9 | 121 | 43 |
| 10/10 | 177 | 39 |
| 10/11 | 207 | 29 |
| **Entire Season** | **200** | **75** |

**Appendix A Table 4. Summary of mean flight heights by hour, night, and for entire season.**

| Night of | Mean Flight Height (m) by hour after sunset | | | | | | | | | | | | Entire Night | | | % of targets below 120 meters |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Mean | STDV | SE | |
| 8/28 | 255 | 346 | 301 | 276 | 314 | 259 | 224 | 214 | 245 | 236 | -- | -- | 267 | 42 | 13 | 18% |
| 8/29 | 186 | 199 | 256 | 191 | 290 | 299 | 276 | 351 | 234 | 145 | 218 | -- | 240 | 60 | 18 | 30% |
| 9/3 | 180 | 244 | 331 | 266 | 242 | 246 | 286 | 283 | 168 | 123 | 163 | -- | 230 | 64 | 19 | 33% |
| 9/4 | 198 | 248 | 253 | 263 | 265 | 254 | 266 | 278 | 263 | 227 | 198 | -- | 247 | 27 | 8 | 20% |
| 9/5 | 175 | 212 | 217 | 218 | 222 | 205 | 211 | 192 | 254 | 195 | 216 | -- | 210 | 20 | 6 | 26% |
| 9/7 | 252 | 276 | 287 | 317 | 235 | 318 | 294 | 356 | 290 | 237 | 169 | -- | 275 | 51 | 15 | 21% |
| 9/8 | 142 | 249 | 220 | 185 | 164 | 175 | 189 | 94 | 161 | 175 | 140 | -- | 172 | 41 | 12 | 35% |
| 9/9 | 266 | 208 | 242 | 395 | 251 | -- | 332 | 362 | 315 | 313 | 303 | -- | 299 | 57 | 18 | 13% |
| 9/10 | -- | 348 | 479 | 466 | 421 | 478 | 519 | 459 | 430 | 371 | 283 | -- | 425 | 72 | 23 | 18% |
| 9/11 | 182 | 352 | 256 | 240 | 241 | 227 | 217 | 154 | 112 | 162 | -- | -- | 214 | 67 | 21 | 34% |
| 9/15 | 337 | 421 | 496 | 387 | 280 | 448 | 471 | 442 | 435 | 385 | 389 | 247 | 395 | 75 | 22 | 10% |
| 9/16 | 192 | 452 | 442 | 452 | 377 | 405 | 308 | 170 | 129 | 151 | -- | 244 | 302 | 129 | 39 | 20% |
| 9/17 | 206 | 229 | 226 | 211 | 260 | 257 | 188 | 268 | -- | 235 | 225 | 226 | 230 | 24 | 7 | 27% |
| 9/18 | 281 | 255 | 279 | 403 | 279 | 276 | 349 | 294 | 293 | 260 | 173 | 121 | 272 | 72 | 21 | 20% |
| 9/19 | 277 | 222 | 172 | 220 | 241 | 357 | 154 | 294 | -- | 402 | -- | -- | 260 | 82 | 27 | 27% |
| 9/29 | 456 | 532 | 508 | 581 | 632 | 639 | 554 | 548 | 518 | 512 | 580 | 563 | 552 | 52 | 15 | 5% |
| 9/30 | 269 | 396 | 344 | 406 | 437 | 353 | 342 | 414 | 411 | 498 | -- | 273 | 377 | 69 | 21 | 18% |
| 10/9 | 76 | 231 | 197 | 281 | 136 | 294 | 326 | 173 | 222 | 293 | 456 | 483 | 264 | 120 | 35 | 27% |
| 10/10 | 170 | 301 | 392 | 523 | 517 | 585 | 558 | 595 | 445 | 539 | 555 | 388 | 464 | 130 | 37 | 9% |
| 10/11 | 271 | 422 | 430 | 571 | 539 | 558 | 473 | 463 | 500 | 487 | 460 | 524 | 475 | 80 | 23 | 10% |
| **Entire Season** | **230** | **307** | **316** | **343** | **317** | **349** | **327** | **320** | **301** | **297** | **302** | **341** | **309** | **103** | **23** | **18%** |

-- indicates no data for that hour

| Appendix A Table 5. Summary of available fall avian radar survey results | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Project Site** | **Number of Survey Nights** | **Number of Survey Hours** | **Landscape** | **Average Passage Rate (t/km/hr)** | **Range in Nightly Passage Rates** | **Avg. Flight Direction** | **Avg. Flight Height (m)** | **(Turbine Ht) % Targets Below Turbine Height** | **Citation** |
| **Fall 1998** | | | | | | | | | |
| Harrisburg, NY | 35 | n/a | Great Lakes plain/ADK foothills | 122 | n/a | 181 | 182 | 45 | Cooper and Mabee 2000 |
| Wethersfield, Wyoming Cty, NY | 35 | n/a | Agricultural plateau | 168 | n/a | 179 | 154 | 57 | Cooper and Mabee 2000 |
| **Fall 2003** | | | | | | | | | |
| Westfield Chautauqua Cty, NY | 30 | 180 | Great Lakes shore | 238 | 10-905 | 199 | 532 | (125 m) 4 % | Cooper *et al.* 2004c |
| Mt. Storm, Grant Cty, WV | 45 | 270 | Forested ridge | 241 | 8-852 | 184 | 410 | n/a | Cooper *et al.* 2004b |
| **Fall 2004** | | | | | | | | | |
| Franklin, Pendleton Cty, WV | 34 | 349 | Forested ridge | 229 | 18-643 | 175 | 583 | (125 m) 8% | Woodlot 2005a |
| Prattsburgh, Steuben Cty, NY | 30 | 315 | Agricultural plateau | 193 | 12-474 | 188 | 516 | (125 m) 3% | Woodlot 2005b |
| Prattsburgh, Steuben Cty, NY | 45 | 292.5 | Agricultural plateau | 200 | 18-863 | 177 | 365 | (125 m) 9.2% | Mabee *et al.* 2005a |
| Martindale, Lancaster, Cty, PA | n/a | n/a | Reclaimed minelands | 187 | n/a | 188 | 436 | (n/a) 8% | Young 2006 |
| Casselman, Somerset Cty, PA | n/a | n/a | Reclaimed minelands | 174 | n/a | 219 | 448 | (n/a) 7% | Young 2006 |
| Deerfield, Bennington Cty, VT (Existing Facility) | 28 | 300 | Forested ridge | 175 | 7-519 | 194 | 438 | (100 m) <1% | Woodlot 2005c |
| Deerfield, Bennington Cty, VT (Western Expansion) | 14 | 159 | Forested ridge | 193 | 8-1121 | 223 | 624 | (100 m) 5% | Woodlot 2005c |
| Deerfield, Bennington Cty, VT (Valley Site) | 13 | 136 | Forested ridge | 150 | 58-404 | 214 | 503 | (100 m) < 1% | Woodlot 2005c |
| Deerfield, Bennington Cty, VT (3 sites combined) | 28 | 595 | Forested ridge | 178 | 7-1121 | 212 | 611 | (100 m) 3% | Woodlot 2005c |
| Sheffield, Caledonia Cty, VT | 18 | 176 | Forested ridge | 114 | 19-320 | 200 | 566 | (125 m) 1% | Woodlot 2006a |
| **Fall 2005** | | | | | | | | | |
| Churubusco, Clinton Cty, NY | 38 | 414 | Great Lakes plain/ADK foothills | 152 | 9-429 | 193 | 438 | (120 m) 5% | Woodlot 2005l |
| Ellenberg, Clinton Cty, NY | n/a | n/a | Great Lakes plain/ADK foothills | 197 | n/a | 162 | 333 | (n/a) 12% | Mabee *et al.* 2006a |
| Dairy Hills, Clinton Cty, NY | n/a | n/a | Agricultural plateau | 94 | n/a | 180 | 466 | (n/a) 10% | Young et al. 2006 |
| Flat Rock, Lewis Cty, NY | n/a | n/a | Great Lakes plain/ADK foothills | 158 | n/a | 184 | 415 | (n/a) 8% | ED&R 2006a |
| Clayton, Jefferson Cty, NY | 37 | 385 | Agricultural plateau | 418 | 83-877 | 168 | 475 | (150 m) 10% | Woodlot 2005m |
| Bliss, Wyoming Cty, NY | 8 | n/a | Agricultural plateau | 440 | 52-1392 | n/a | 411 | (125 m) 13% | Young 2006 |
| Perry, Wyoming Cty, NY | n/a | n/a | Agricultural plateau | 64 | n/a | 180 | 466 | (125 m) 10% | Young 2006 |
| Sheldon, Wyoming Cty, NY | 36 | 347 | Agricultural plateau | 197 | 43-529 | 213 | 422 | (120 m) 3% | Woodlot 2005n |
| Howard, Steuben Cty, NY | 39 | 405 | Agricultural plateau | 481 | 18-1434 | 185 | 491 | (125 m) 5% | Woodlot 2005o |
| Fairfield, Herkimer Cty, NY | 38 | 423 | Agricultural plateau | 691 | 116-1351 | 198 | 516 | (125 m) 4% | Woodlot 2005p |
| Jordanville, Herkimer Cty, NY | 38 | 404 | Agricultural plateau | 380 | 26-1019 | 208 | 440 | (125 m) 6% | Woodlot 2005q |
| Munnsville, Madison Cty, NY | 31 | 292 | Agricultural plateau | 732 | 15-1671 | 223 | 644 | (118 m) 2% | Woodlot 2005r |
| Deerfield, Bennington Cty, VT | 32 | 324 | Forested ridge | 559 | 3-1736 | 221 | 395 | (100 m) 13% | Woodlot 2005s |
| Kibby, Franklin Cty, ME (Mountain) | 12 | 115 | Forested ridge | 565 | 109-1107 | 167 | 370 | (125 m) 16% | Woodlot 2006d |
| Kibby, Franklin Cty, ME (Range 1) | 12 | 101 | Forested ridge | 201 | 12-783 | 196 | 352 | (125 m) 12% | Woodlot 2006d |
| Kibby, Franklin Cty, ME (Valley Site) | 5 | 13 | Forested valley | 452 | 52-995 | 193 | 391 | (125 m) 16% | Woodlot 2006d |
| Mars Hill, Aroostook Cty, ME | 18 | 117 | Forested ridge | 512 | 60-1092 | 228 | 424 | (120 m) 8% | Woodlot 2005t |
| **Fall 2006** | | | | | | | | | |
| Chateaugay, Franklin Cty, NY | 35 | 327 | Agricultural plateau | 643 | 38-1373 | 212 | 431 | (120 m) 8% | Woodlot 2006j |
| Wethersfield, Wyoming Cty, NY | 56 | n/a | Agricultural plateau | 256 | 31-701 | 208 | 344 | (125 m) 11% | Mabee et al. 2006c |
| Centerville, Allegany Cty, NY | 57 | n/a | Agricultural plateau | 259 | 12-877 | 208 | 350 | (125 m) 12% | Mabee et al. 2006c |
| Lempster, Sullivan Cty, NH | 32 | 290 | Forested ridge | 620 | 133-1609 | 206 | 387 | (125 m) 8% | Woodlot 2007a |
| Stetson, Penobscot Cty, ME | 12 | 77 | Forested ridge | 476 | 131-1192 | 227 | 378 | (125 m) 13% | Woodlot 2007b |
| Cape Vincent, Jefferson Cty, NY | 63 | 508 | Great Lakes plain | 346 | n/a | 209 | 490 | (125 m) 8% | WEST 2007 |
| **Fall 2007** | | | | | | | | | |
| Coos Cty, NH | 29 | 232 | Forested ridge | 366 | 54 to 1234 | 223 | 343 | (125 m) 15% | Stantec 2007b |
| Wolfe Island, Ontario, Canada* | n/a | n/a | Interior Lake Island | n/a | n/a | 95 | 233 | (125m) 23% | EchoTrack 2008 |
| Laurel Mountain, VA | 20 | 212 | Forested ridge | 321 | 76-513 | 209 | 533 | (130 m) 6% | Woodlot 2007f |
| Rollins, Penobscot Cty, ME | 22 | 231 | Forested ridge | 368 | 82-953 | 284 | 343 | 13% (120 m) | Woodlot 2008 |

*Certain pieces of information are not available for comparison due to differences in survey methodology and design.

# Appendix B

Raptor Survey Data Tables

**Appendix B Table 1.** Species composition of raptors observed during raptor surveys

| Species | 8/26 | 9/2 | 9/3 | 9/11 | 9/17 | 9/18 | 9/29 | 9/30 | 10/9 | 10/10 | 10/13 | 10/14 | Entire Season |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| bald eagle | | 1 | | | | 1 | | | | 2 | | | 4 |
| broad-winged hawk | 1 | 1 | | 3 | 1 | | | | | | | | 6 |
| merlin | | | 1 | | | | | 1 | | | | | 2 |
| northern goshawk | | | 1 | | | | | 1 | | | | | 2 |
| osprey | | | | 1 | | | | | | | | | 1 |
| red-tailed hawk | | | | 2 | | | | 3 | | | 2 | 1 | 8 |
| sharp-shinned hawk | | | | | 3 | 2 | | 2 | | | 1 | | 8 |
| turkey vulture | 2 | 1 | | 6 | 4 | 3 | 2 | 9 | | | | | 27 |
| unknown buteo | | 1 | | | | | | 1 | | | | | 2 |
| **Daily Totals** | **3** | **4** | **2** | **12** | **8** | **6** | **2** | **17** | **0** | **2** | **3** | **1** | **60** |
| **Hours of Observation** | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 84 |
| **Daily Passage Rate** | 0.4 | 0.6 | 0.3 | 1.7 | 1.1 | 0.9 | 0.3 | 2.4 | 0.0 | 0.3 | 0.4 | 0.1 | 0.7 |

**Appendix B Table 2.** Observation totals of raptors by hour

| Species | 9:00-10:00 | 10:00-11:00 | 11:00-12:00 | 12:00-1:00 | 1:00-2:00 | 2:00-3:00 | 3:00-4:00 | Grand Total |
|---|---|---|---|---|---|---|---|---|
| bald eagle | 3 | | 1 | | | | | 4 |
| broad-winged hawk | 1 | 2 | | | 3 | | | 6 |
| merlin | | | | | | 1 | 1 | 2 |
| northern goshawk | | | 1 | | 1 | | | 2 |
| osprey | | | | | | 1 | | 1 |
| red-tailed hawk | | | 1 | 2 | 1 | 1 | 3 | 8 |
| sharp-shinned hawk | 1 | 2 | 3 | 1 | | 1 | | 8 |
| turkey vulture | 2 | 3 | | 3 | 7 | 7 | 5 | 27 |
| unknown buteo | | | 1 | 1 | | | | 2 |
| **Hourly totals** | **7** | **7** | **7** | **7** | **12** | **11** | **9** | 60 |

| **Appendix B Table 3.** Raptor flight altitudes by species | | | | |
|---|---|---|---|---|
| **Species** | **120 m or greater** | **less than 120 m** | **outside Project area** | **Entire Season** |
| bald eagle | | 4 | | 4 |
| broad-winged hawk | 2 | 3 | 1 | 6 |
| merlin | 1 | 1 | | 2 |
| northern goshawk | 1 | 1 | | 2 |
| osprey | | | 1 | 1 |
| red-tailed hawk | | 8 | | 8 |
| sharp-shinned hawk | 1 | 7 | | 8 |
| turkey vulture | 12 | 12 | 3 | 27 |
| unknown buteo | 1 | | 1 | 2 |
| **Entire Season** | **18** | **36** | **6** | **60** |

**Appendix B Table 4.** Incidental observations of other birds

| Date | Species |
|---|---|
| 9/2/2008 | American Goldfinch |
| 9/2/2008 | black-and-white warbler |
| 9/2/2008 | dark-eyed junco |
| 9/2/2008 | red-eyed vireo |
| 9/2/2008 | common raven |
| 9/2/2008 | black-capped chickadee |
| 9/2/2008 | American Crow |
| 9/3/2008 | American Goldfinch |
| 9/3/2008 | northern flicker |
| 9/3/2008 | blue jay |
| 9/3/2008 | black-capped chickadee |
| 9/3/2008 | dark-eyed junco |
| 9/3/2008 | common raven |
| 9/3/2008 | common raven |
| 9/3/2008 | red-eyed vireo |
| 9/11/2008 | dark-eyed junco |
| 9/11/2008 | common yellowthroat |
| 9/11/2008 | red-eyed vireo |
| 9/11/2008 | American Goldfinch |
| 9/11/2008 | golden-crowned kinglet |
| 9/11/2008 | blue jay |
| 9/11/2008 | white-throated sparrow |
| 9/11/2008 | magnolia warbler |
| 9/11/2008 | common raven |
| 9/11/2008 | northern parula |
| 9/11/2008 | yellow warbler |
| 9/11/2008 | ruby-throated hummingbird |
| 9/11/2008 | yellow-breasted sapsucker |
| 9/17/2008 | yellow-breasted sapsucker |
| 9/17/2008 | alder flycatcher |
| 9/17/2008 | white-throated sparrow |
| 9/17/2008 | yellow-rumped warbler |
| 9/17/2008 | common raven |
| 9/17/2008 | blue jay |
| 9/29/2008 | common raven |
| 9/29/2008 | blue jay |
| 9/29/2008 | white-throated sparrow |
| 9/29/2008 | dark-eyed junco |
| 9/29/2008 | American Crow |
| 9/29/2008 | common yellowthroat |
| 9/30/2008 | common raven |
| 9/30/2008 | blue jay |
| 9/30/2008 | dark-eyed junco |
| 9/30/2008 | ruffed grouse |
| 9/30/2008 | white-throated sparrow |
| 9/30/2008 | common yellowthroat |
| 9/30/2008 | black-capped chickadee |
| 9/30/2008 | chipping sparrow |
| 9/30/2008 | American Crow |
| 9/30/2008 | black-throated green warbler |
| 9/30/2008 | ruby-crowned kinglet |
| 10/9/2008 | blue jay |
| 10/9/2008 | white-throated sparrow |
| 10/9/2008 | yellow-rumped warbler |
| 10/9/2008 | black-capped chickadee |
| 10/9/2008 | common raven |
| 10/9/2008 | ruffed grouse |
| 10/9/2008 | american robin |
| 10/13/2008 | white-throated sparrow |
| 10/13/2008 | black-capped chickadee |
| 10/13/2008 | blue jay |
| 10/13/2008 | dark-eyed junco |
| 10/13/2008 | yellow-rumped warbler |
| 10/13/2008 | ruffed grouse |
| 10/13/2008 | common raven |
| 10/13/2008 | American Goldfinch |
| 10/13/2008 | canada goose |

**Appendix B Table 5.** Summary of Regional Fall (August to October) Migration Surveys*

| Location | Obs Hours | BV | TV | OS | BE | NH | SS | CH | NG | RS | BW | RT | RL | GE | AK | ML | PG | SW | UR | UB | UA | UF | UE | TOTAL | Birds /Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cadillac Mountain, ME *** | 242 | 0 | 40 | 230 | 21 | 145 | 1141 | 31 | 7 | 1 | 268 | 56 | 1 | 0 | 494 | 99 | 35 | 0 | 63 | 6 | 0 | 0 | 0 | 2,638 | 10.9 |
| **Little Round Top, NH*** | 84 | 0 | 18 | 41 | 32 | 1 | 34 | 12 | 0 | 0 | 3071 | 14 | 0 | 1 | 10 | 1 | 0 | 0 | 31 | 3 | 4 | 2 | 0 | 3,275 | 38.8 |
| **Pack Monadnock, NH*** | 338 | 0 | 21 | 255 | 48 | 66 | 1064 | 131 | 16 | 30 | 6835 | 74 | 0 | 0 | 180 | 51 | 17 | 0 | 15 | 6 | 3 | 2 | 0 | 8,814 | 26.1 |
| **Allegheny Front, PA *** | 476 | 15 | 92 | 108 | 56 | 36 | 899 | 136 | 5 | 10 | 3887 | 475 | 1 | 4 | 53 | 27 | 12 | 0 | 64 | 37 | 23 | 5 | 0 | 5,945 | 12.5 |
| **Hawk Mountain, PA *** | 610 | 19 | 108 | 449 | 181 | 174 | 2717 | 386 | 0 | 20 | 4289 | 176 | 0 | 10 | 286 | 95 | 58 | 0 | 44 | 13 | 15 | 10 | 0 | 9,050 | 14.8 |
| **Barre Falls, MA *** | 199 | 0 | 193 | 165 | 51 | 23 | 702 | 62 | 11 | 7 | 5235 | 40 | 0 | 0 | 135 | 30 | 19 | 0 | 12 | 1 | 0 | 0 | 0 | 6,686 | 33.6 |
| **Shatterack Mountain, MA *** | 116 | 0 | 21 | 70 | 15 | 18 | 391 | 15 | 0 | 5 | 5039 | 11 | 0 | 1 | 44 | 5 | 7 | 0 | 6 | 0 | 0 | 0 | 0 | 5,648 | 48.8 |
| **Montreal West Island, QC *** | 160 | 0 | 174 | 39 | 20 | 10 | 151 | 0 | 0 | 11 | 2142 | 157 | 0 | 0 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,735 | 17.1 |

* Data obtained from HMANA website.

**Abbreviation Key:**

BV - Black Vulture
TV - Turkey Vulture
OS - Osprey
BE - Bald Eagle
NH - Northern Harrier
SS - Sharp-shinned Hawk
CH - Cooper's Hawk
NG - Northern Goshawk
RS - Red-shouldered Hawk
BW - Broad-winged Hawk
RT - Red-tailed Hawk
RL - Rough-legged Hawk
GE - Golden Eagle
AK - American Kestrel
ML - Merlin
PG - Peregrine Falcon
SW - Swainson's Hawk
UR - unidentified Raptor
UB - unidentified Buteo
UA - unidentified Accipiter
UF - unidentified Falcon
UE - unidentified Eagle

**Appendix B Table 6.** Summary of available fall raptor survey results

| Project Site | Survey Period | # of Survey Days | # of Survey Hours | Landscape | Total # Observed | # of Species Observed* | Ave. Passage Rate (Raptors/Hr) | Range in Daily Passage Rates | (Turbine Ht) % Raptors Below Turbine Height | Citation |
|---|---|---|---|---|---|---|---|---|---|---|
| **Fall 1996** | | | | | | | | | | |
| Deerifield, Bennington County, VT | Sept. 11 - Nov. 3 | 20 | 80 | Forested ridge | 430 | 12 | 5.38 | n/a | n/a | Kerlinger 1996 |
| **Fall 1998** | | | | | | | | | | |
| Harrisburg, Lewis County, NY | Sept. 2 - Oct. 1 | 13 | 68 | Great Lakes plain/ADK foothills | 554 | 12 | 8.1 | n/a | n/a (47 m mean flight height) | Cooper and Mabee 2000 |
| Wethersfield, Wyoming Cty, NY | Sept. 2 - Oct. 1 | 24 | 107 | Agricultural plateau | 256 | 12 | 2.4 | n/a | n/a (48 m mean flight height) | Cooper and Mabee 2000 |
| **Fall 2004** | | | | | | | | | | |
| Prattsburgh, Steuben Cty, NY | Sept. 2 - Oct. 28 | 13 | 73 | Agricultural plateau | 220 | 10 | 3.01 | n/a | (125 m) 62% | Woodlot 2005b |
| Cohocton, Stueben, Cty, NY | Sept. 2 - Oct. 28 | 8 | 41.3 | Agricultural plateau | 128 | 8 | 3.1 | n/a | (125 m) 80% | Woodlot 2005u |
| Deerfield, Bennington Cty, VT (Existing Facility) | Sept. 2 - Oct. 31 | 10 | 60 | Forested ridge | 147 | 11 for both sites combined<br>11 for both sites combined | 2.45 | n/a | (100 m) 9% for both sites combined<br>(100 m) 9% for both sites combined | Woodlot 2005c |
| Deerfield, Bennington Cty, VT (Western Expansion) | Sept. 2 - Oct. 31 | 10 | 57 | Forested ridge | 725 | | 12.72 | n/a | | Woodlot 2005c |
| Sheffield, Caledonia Cty, VT | Sept. 11 - Oct. 14 | 10 | 60 | Forested ridge | 193 | 10 | 3.2 | n/a | (125 m) 31% | Woodlot 2006a |
| **Fall 2005** | | | | | | | | | | |
| Cohocton, Stueben, Cty, NY | Sept. 7 - Oct. 1 | 7 | 40.12 | Agricultural plateau | 131 | 10 | 3.27 | 0.83-5.25 | (125) 63% | Woodlot 2005u |
| Churubusco, Clinton Cty, NY | Sept. 6 - Oct. 22 | 10 | 60 | Great Lakes plain/ADK foothills | 217 | 15 | 3.62 | n/a | (120 m) 69% | Woodlot 2005l |
| Dairy Hills, Clinton Cty, NY | Sept. 11 - Oct. 10 | 4 | 16 | Agricultural plateau | 48 | 7 | 3 | n/a | n/a | Young et al. 2006 |
| Howard, Steuben Cty, NY | Sept. 1 - Oct. 28 | 10 | 57 | Agricultural plateau | 206 | 12 | 3.6 | 0.5-13.67 | (91 m) 65% | Woodlot 2005o |
| Munnsville, Madison Cty, NY | Sept. 6 - Oct. 31 | 11 | 65 | Agricultural plateau | 369 | 14 | 5.68 | 1.33-15.60 | (118 m) 51% | Woodlot 2005r |
| Mars Hill, Aroostook Cty, ME | Sept. 9 - Oct. 13 | 8 | 42.5 | Forested ridge | 115 | 13 | 1.52 | 0.25-2.86 | (120 m) 42% | Woodlot 2005t |
| Lempster, Sullivan County, NH | Fall 2005 | 10 | 80 | Forested ridge | 264 | 10 | 3.3 | n/a | (125 m) 40% | Woodlot 2007c |
| Clayton, Jefferson Cty, NY | Sept. 9 - Oct. 16 | 11 | 63.5 | Agricultural plateau | 575 | 13 | 9.1 | 3.25-18.67 | (150 m) 89% | Woodlot 2005m |
| **Fall 2006** | | | | | | | | | | |
| Stetson, Washington Cty, ME | Sept. 14 - Oct. 26 | 7 | 42 | Forested ridge | 86 | 11 | 2.05 | 0.00-6.83 | (120 m) 63% | Woodlot 2007b |
| **Fall 2006** | | | | | | | | | | |
| Rollins, Penobscot Cty, ME | Sept. 13 - Oct. 16 | 12 | 89 | Forested ridge | 144 | 12 | 1.8 | n/a | (120 m) 82% | Stantec 2007c |

*The no. of species observed may include unidentified species (buteo, accippiter, eagle, etc) as separate species.

# Appendix 7-7
# Addendum to the Spring and Fall 2008 Bird Migration Survey Reports

The results for the Spring and Fall Migration Survey reports (Appendices 7-6 and 7-7) were presented with calculations based on a maximum turbine height of 120 meters (393 feet). These results have been recalculated for the proposed maximum turbine height of 141 meters (463 feet).

For the spring 2008 raptor survey, the results did not change. In fall 2008, the recalculation of turbine height from 120 m to 141 m resulted in one additional observation of a merlin being considered in the project area and flying at a height below turbine height. This resulted in a total of 37 birds considered in the project area and below turbine height rather than 36 birds. The revised results for percent of birds in the project area and below turbine height are presented below.

| Season | At 120 m | At 141 m (recalculated) |
|---|---|---|
| Fall 2008 | 67% | 69% |

For the radar survey, the revised results are presented below.

| Season | At 120 m | At 141 m (recalculated) |
|---|---|---|
| Spring 2008 | 21% | 26% |
| Fall 2008 | 18% | 23% |

This incremental increase in the percentage documented below maximum turbine height is consistent with the findings from the Spring and Fall Migration Survey reports which indicated that the vast majority of bird migration in the area occurs well above the height of the proposed turbines and these flight heights demonstrate limited avian mortality risk.

# Appendix 7-8
# Eagle Summary Report

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## APPENDICES

Appendix A Survey Location Map
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# 1.0 INTRODUCTION

Between 2008 and 2010, Stantec Consulting Services Inc. (Stantec) completed aerial surveys for bald eagle (*Haliaeetus leucocephalus*) nests, surveys, raptor migration surveys and eagle activity surveys in association with the proposed Oakfield Wind Project Amendment (Project) in Oakfield, Maine (Appendix A).

This report includes a summary of the methods used for each survey and a summary of the findings for those surveys.

# 2.0 EAGLE NEST AERIAL FLIGHT SURVEY

## 2.1 METHODS

Stantec conducted aerial nest surveys for bald eagle nests during the nesting season (late April to mid June) in 2009 and 2010. Prior to the surveys each year, Stantec reviewed information provided by the Maine Department of Inland Fisheries and Wildlife (MDIFW) regarding known active and historic eagle nest locations near the Project area. Stantec also consulted with Charlie Todd of the MDIFW and Mark McCollough of the U.S. Fish and Wildlife Service (USFWS), who both confirmed that the aerial survey for that year was performed at an appropriate time of year and employed the appropriate methods. The survey timing and methodology was consistent with Guidelines for Building and Operating Wind Energy Facilities in Maine (USFWS Maine Field Office, November 2009). In compliance with United States Fish and Wildlife Service (USFWS) National Bald Eagle Management Guidelines (May 2007), Stantec also notified Mark McCullough of the USFWS Maine Field Office that flights were planned in the area surrounding the Project.

The survey consisted of low altitude passes from a single-engine aircraft, approximately 500 feet above ground level, along the shoreline of identified waterbodies. In 2009, waterbodies within a 3-mile radius of proposed turbine locations for the Project were surveyed based on recommendations made by MDIFW and USFWS. In 2010 the survey radius was increased to 4-miles to correspond with standards recommended in the USFWS Maine Field Office Guidance (November 2009) which states that, “four miles is an average distance that Maine bald eagles may be expected to travel”. The shorelines of the ponds and rivers were surveyed for active or historic eagle nest sites. Locations of new nests identified were recorded with a Global Positioning System receiver. Incidental observations of adult and juvenile bald eagles were also recorded.

## 2.2 RESULTS

On April 30, 2009, Stantec, along with Mr. Todd of the MDIFW, conducted an aerial eagle nest survey of nine lakes within a 3-mile radius of proposed turbine locations for the project, including Mattawamkeag Lake, Upper Mattawamkeag Lake, Pleasant Lake, Skitacook Lake, Mud Lake, Meduxnekeag Lake (Drews Lake), Twomey Lake, Spaulding Lake, and Long Lake. Stantec also surveyed two known bald eagle nest locations on Mattawamkeag Lake and Drews Lake (Appendix A).

In 2009, no new active nests were identified within this search area. Stantec surveyed the known bald eagle nest locations on Mattawamkeag Lake and Drews Lake. The nest on Mattawamkeag Lake was found to be empty. The nest on Drews Lake (MDIFW Nest #344B) was found to be active, with one adult bald eagle observed in the nest. The adult bald eagle was sitting in a position indicating that it may have been covering hatched eaglets. However, no eaglets were observed in the nest. This nest is located east of the location shown on the MDIFW Essential Habitat Maps and is shown in Appendix A. No adult or juvenile bald eagles or bald eagle nests were observed on the remaining lakes and rivers within the aerial flight survey area.

In 2010, Stantec conducted aerial eagle nest surveys on May 5 and June 9. During the first flight on May 5, eleven lakes within a 4-mile radius of proposed turbine locations for the project were surveyed including Long Lake, Spaulding Lake, Timoney Lake, Cochrane Lake, County Road Lake, Gould Pond,

Meduxnekeag Lake (Drews Lake), Skitacook Lake, Mud Lake, Pleasant Lake, and Mattawamkeag Lake, as well as a stretch of the East Branch of the Mattawamkeag River (Appendix A).

During the first flight on May 5, Stantec did not identify any active bald eagle nests within four miles of the Project area. Stantec located a known bald eagle nest on Drews Lake (MDIFW Nest #344B), but this nest, which was active during the 2009 survey, was found to be empty. One adult bald eagle was seen perched near the nest location. Stantec searched for an alternate nest location on Drews Lake (Nest #344A) but was unable to locate a nest. Stantec also located a known bald eagle nest on Mattawamkeag Lake (MDIFW Nest #143), but the nest was also found to be empty. Two adult bald eagles were seen perched in a neighboring tree. No other bald eagles or nests were observed in the Project area.

During the second flight on June 9, Stantec surveyed the nest locations identified during the first flight on Mattawamkeag Lake and Drews Lake. Both nests were found to be empty. Stantec also surveyed the shoreline of Drews Lake but no new nests were observed. An adult bald eagle was observed near the mapped 344A nest site, but no nest was observed in this area.

## 3.0 RAPTOR MIGRATION SURVEY AND EAGLE ACTIVITY SURVEY

### 3.1 METHODS

Raptor migration and eagle activity surveys were conducted over three years at three locations in the Project area: Sam Drew Mountain (2008, 2009, 2010), which provided good views to the south, east and west;[1] May Mountain (2009, 2010)[2], which provided good views in all directions; and Hunt Ridge (2010)[3], which provided good views in all directions. During surveys, a Stantec biologist scanned the sky and surrounding landscape with the unaided eye and binoculars to search for eagles and other raptors. Surveys were conducted in a variety of weather conditions, although the majority of survey days were targeted for mostly clear days with good visibility. Surveys were conducted for at least seven hours per day, typically from 9 am to 4 pm, during the peak hours of thermal development and raptor movement. The flight paths and approximate flight height, including time directly over the Project ridge, as well as age and behavior, were recorded for each eagle or raptor observed. For each observation, the horizontal flight path and vertical flight height[4] were documented. Because each bird could be observed in multiple locations during their flight path, the number of flight positions may be greater than the number of eagles observed. The observations were summarized by survey day and for the entire survey period. Vertical flight heights were compared to the maximum turbine height of 140 meters [m] (448 feet ['']).

The results of each survey are discussed below and are summarized in Appendix B, Tables 1-5.

### 3.2 EAGLES DOCUMENTED DURING RAPTOR MIGRATION SURVEY 2008

In 2008, Stantec conducted 12 days (79 hours) of raptor migration surveys in spring. Spring surveys were conducted between April 25 and May 30. Fall surveys were conducted on 12 days (84 hours) from August 26 to October 14. Both spring and fall surveys were conducted from the meteorological (met) tower opening on Sam Drew Mountain. During spring 2008, one bald eagle was observed flying along the lower slope of the ridge and above the valley. During fall 2008, four bald eagles were observed. Each eagle was observed within the Project area at varying heights and positions (Appendix B, Table 2). These five observations include two adults, two subadults, and one juvenile.

[1] Views down into the valley to the northwest were obstructed due to the nature of the gradually sloping terrain and vegetation. However, the observer was able to see over the tops of surrounding trees to account for raptors flying at eye level or higher over the northwestern valley.
[2] Following surveys conducted in 2009 and 2010, the project layout was revised and no longer includes turbines within the vicinity of this location. Surveys were discontinued after April 13, 2010.
[3] The Hunt Ridge site was added in 2010, based on changes in the project layout.
[4] Vertical flight height was compared to the proposed maximum turbine height of 463 feet (141 meters)

For each observation, the horizontal flight path and the vertical flight height were documented. Because each bird could be observed in multiple locations during their flight path, a total of seven flight path locations were documented. Two flight paths were parallel to the ridge and included flight heights below maximum turbine height for some portion of their flight path over the ridge.

No bald eagles were observed on 19 of 24 days. The bald eagle passage rate was 0.01 eagles/observation hour in the spring and 0.05 eagles/observation hour in the fall.

## 3.3 EAGLES DOCUMENTED DURING EAGLE ACTIVITY SURVEY 2009

In 2009, USFWS requested an additional 15 calendar days of surveys be conducted between late June and mid-September to further characterize eagle use in the Project area. In particular, USFWS requested that the additional surveys focus on eagle activity during nesting and dispersal periods and any ridge crossings between Spaulding Lake and Drews Lake. Surveys were conducted from two locations: Sam Drew Mountain and May Mountain.[5]

### 3.3.1 Summer – Fall 2009

*Sam Drew Mountain*
From July 9 to September 10, 2009, Stantec conducted 16 days (128 hours) of eagle activity surveys from the met tower opening on Sam Drew Mountain, at the same location as previous surveys conducted in spring 2008 and fall 2008. During this time, seven observations of bald eagles were documented, all of which were observed within the Project area at varying heights and positions (Appendix B, Table 3). These seven observations include four adults, two subadults, and one juvenile. Five of these observations occurred between 10 am and 1 pm. Six of these observations included linear and/or circle soaring behavior. On 11 of the 16 days, no bald eagles were observed. The bald eagle passage rate was 0.05 eagles/observation hour within the Project area.

A total of ten flight path locations were documented, all of which were inside the Project area. Five flight paths were over the ridge, four of which included flight heights below maximum turbine height for some portion of the flight path; two were below maximum turbine height and were parallel to the ridge, and three were perpendicular to the ridge. For these five flight paths, the total flight time over the ridge was 9 minutes, which is 0.1 percent of the total observation time during the season. Four flight paths were along the slope of the ridge, two of which included flight heights below maximum turbine height for some portion of the flight path. One flight path was over the valley at a flight height greater than maximum turbine height. No flight paths were indicative of crossings between Spaulding Lake and Drews Lake.

*May Mountain*
From August 24 to October 16, 2009, 15 days (106.5 hours) of eagle surveys were conducted from the met tower opening on May Mountain (also known as Robinson Mountain). During this time, seven observations of bald eagles were documented, none of which were observed within the Project area (Appendix B, Table 3). The bald eagle passage rate was 0.07 eagles/observation hour for the entire survey period and 0.00 eagles/observation hour within the Project Area. No eagles were observed flying over the ridge at heights below maximum turbine height.

## 3.4 EAGLES DOCUMENTED DURING EAGLE ACTIVITY SURVEY 2010

In 2010, Stantec conducted an additional 35 calendar days of survey between mid-March and mid-October to further characterize eagle use in the Project area. Surveys focused on eagle activity during early migration, nesting and dispersal periods, and were conducted from three locations: Sam Drew Mountain, Hunt Ridge, and May Mountain[6].

[5] Following surveys conducted in 2009 and 2010, the project layout was revised and no longer includes turbines within the vicinity of this location. Surveys were discontinued after April 13, 2010.
[6] Ibid.

### 3.4.1 Spring 2010

*Sam Drew Mountain*
From March 16 to May 28, 2010, 15 days (102.5 hours) of eagle surveys were conducted from the met tower opening on Sam Drew, at the same location as previous surveys in 2008 and 2009. During this time, 11 observations of bald eagles were documented, seven of which were observed within the Project area at varying heights and positions (Appendix B, Table 4). These seven observations include six adults and one sub-adult. Five of these observations occurred between 10 am and 12 pm. On nine of the 15 days, no bald eagles were observed. The bald eagle passage rate was 0.11 eagles/observation hour for the entire survey period and 0.07 eagles/observation hour within the Project area.

A total of 19 flight path locations were documented within the Project area. Five flight paths were over a project ridge, three of which were observed over Hunt Ridge at flight heights above maximum turbine height and two of which were observed above Sam Drew and included vertical flight heights below maximum turbine height for a portion of the flight path. For these five flight paths, the total flight time over a project ridge was 2 minutes and 5 seconds, and the total flight time over the ridge at heights less than maximum turbine height was 30 seconds, 0.008 percent of the total observation time during the season. Nine flight paths were along the slope of the ridge, three of which included flight heights below maximum turbine height. Five flight paths included portions over the valley, none of which included portions below maximum turbine height.

*Hunt Ridge*
From March 18 to May 27, 2010, 15 days (101 hours) of eagle surveys were conducted from the met tower opening on Hunt Ridge. During this time, 20 observations of bald eagles were documented, 11 of which were observed within the Project area at varying heights and positions (Appendix B, Table 4). These 11 observations include adults and two subadults, one juvenile, and one eagle of unknown age. Eight of these observations occurred between 10 am and 12 pm. On nine of 15 days, no bald eagles were observed. The bald eagle passage rate was 0.20 eagles/observation hour for the entire survey period and 0.11 eagles/observation hour within the Project area.

A total of 30 flight path locations were documented within the Project area. Eleven flight paths were over the ridge. Eight of these flight paths included flight heights below maximum turbine height for a portion of the flight path; two of these flight paths with heights below maximum turbine height were parallel to the ridge, and six were perpendicular to the ridge. For these eight flight paths, the total flight time over the ridge was 12 minutes and 30 seconds, and the total flight time over the ridge at heights less than maximum turbine height was 4 minutes and 40 seconds, which is 0.07 percent of the total observation time during the season. Thirteen flight paths were along the slope of the ridge, seven of which included flight heights below maximum turbine height for a portion of the flight path. Six flight paths included portions over the valley, three of which included flight heights below maximum turbine height for a portion of the flight path.

*May Mountain*
From March 16 to April 13, 2010, three days (21 hours) of eagle surveys were conducted from the met tower opening on May Mountain, at the same location as previous surveys in summer and fall 2009. During this time, no observations of bald eagles were documented. Based on a change in the project layout rendering the May Mountain site outside the project area, raptor observations were discontinued for the remainder of 2010.

### 3.4.2 Summer-Fall 2010

*Sam Drew Mountain*
From June 17 to October 14, 2010, 20 days (140 hours) of eagle surveys were conducted from the met tower opening on Sam Drew, at the same location as previous surveys in 2008 and 2009. During this time, 15 observations of bald eagles were documented, seven of which were observed within the Project area at varying heights and positions (Appendix B, Table 5). These seven observations included three adults, two sub-adults, one juvenile and one of undetermined age. The bald eagle passage rate was 0.11

eagles/observation hour for the entire survey period and 0.05 eagles/observation hour within the Project area.

A total of 15 flight path locations were documented within the Project area. Seven flight paths were over the ridge, three of which included vertical flight heights below maximum turbine height for a portion of the flight path; two of these flight paths below maximum turbine height were parallel to the ridge, and one was perpendicular to the ridge. Six flight paths were along the slope of the ridge, one of which included flight heights below maximum turbine height. Two flight paths included portions over the valley, neither of which were below maximum turbine height.

*Hunt Ridge*
From June 17 to October 14, 2010, 20 days (140 hours) of eagle surveys were conducted from the met tower opening on Hunt Ridge. During this time, 13 observations of bald eagles were documented, seven of which were observed within the Project area at varying heights and positions (Appendix B, Table 5). These seven observations include four adults, one sub-adult and two juveniles. Two of these observations occurred between 10 am and 12 pm. On 11 of 20 days, no bald eagles were observed. The bald eagle passage rate was 0.09 eagles/observation hour for the entire survey period and 0.05 eagles/observation hour within the Project Area.

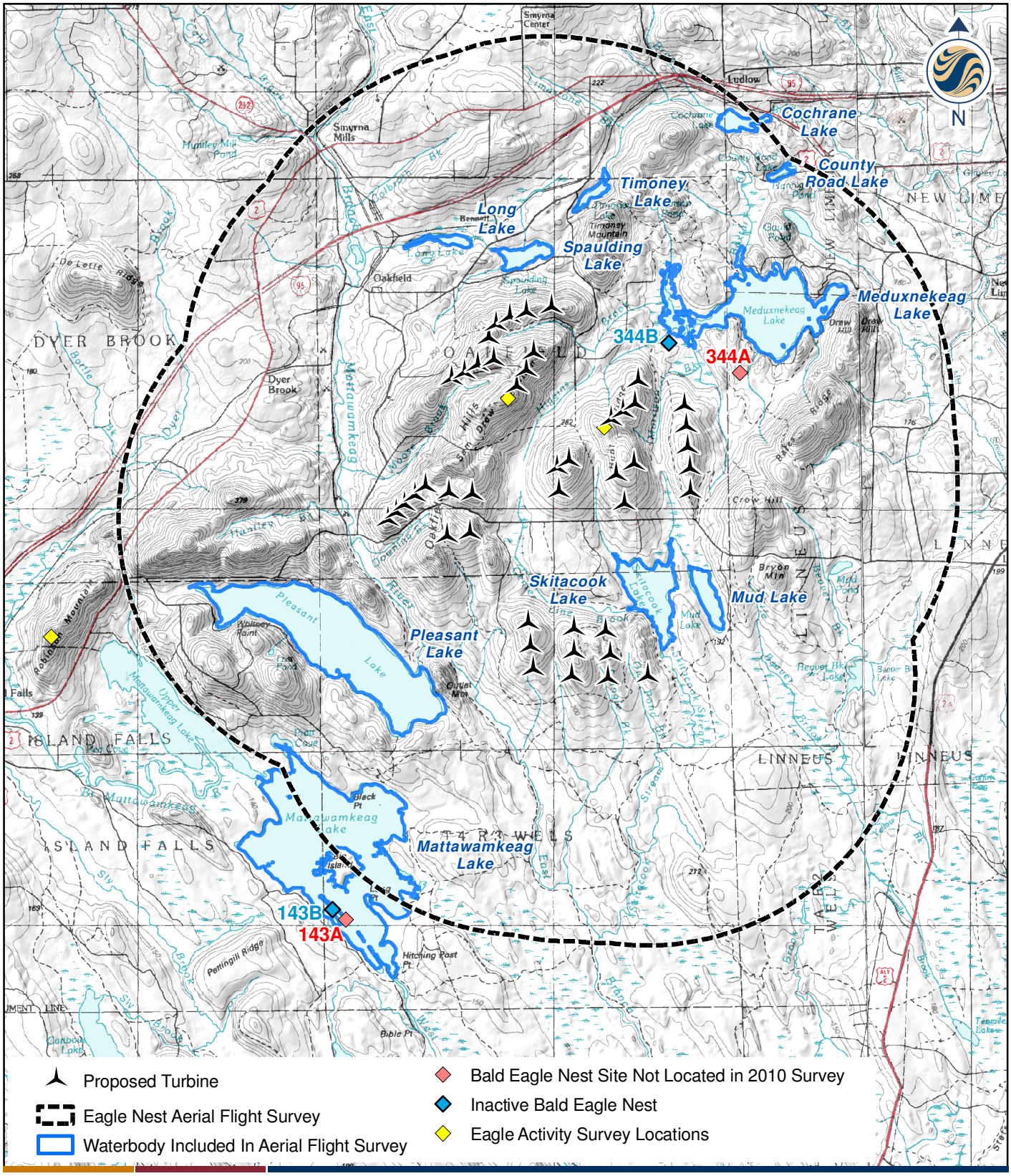
A total of 26 flight path locations were documented within the Project area. Nine flight paths were over the ridge, eight of which included flight heights below maximum turbine height for a portion of the flight path; four of these flight paths with heights below maximum turbine height were parallel to the ridge, and four were perpendicular to the ridge. Thirteen flight paths were along the slope of the ridge, eight of which included flight heights below maximum turbine height for a portion of the flight path. Four flight paths were over the valley, three of which included flight heights below maximum turbine height for a portion of the flight path.

## 4.0 CONCLUSION

One bald eagle nest site is located within four miles of proposed turbine locations. This nest was active in 2009 and was inactive in 2010. Eagle activity surveys were conducted for a total of 128 days (900 hours) during three years (Appendix B, Table 1), resulting in an overall bald eagle passage rate within the Project area of 0.05 eagles/hour which is less than the typical rate observed at other survey locations.

The findings from these surveys should be interpreted within the context of the best available information about bald eagle interactions with wind projects (Appendix C). Post-construction studies and other literature on raptor collision mortality in the eastern United States have documented fewer than 40 raptor fatalities reported during 15,000 turbine searches and suggest that raptors are not vulnerable to collision at modern wind facilities. Although fatalities of related eagle species have been documented at several facilities outside the United States, these generally occur in geographic settings that are significantly different than that at Oakfield (Appendix C).

# Appendix A
# Survey Location Map

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**Client/Project**
**Oakfield Wind Project**
**Oakfield, Maine**

Figure No.
**1**

Title
**Bald Eagle Survey Map**

11/16/2010

00518-F01-EagleSurveyPermitAppendix.mxd

# Appendix B
# Summary of Survey Results

| Appendix B Table 1. Summary of Bald Eagle Observations at Proposed Oakfield Wind Project 2008-2010 | | | | | |
|---|---|---|---|---|---|
| | **Days** | **Hours** | **Bald Eagles Observed** | **Bald Eagles Observed within Project Area** | **Bald Eagle Observation Rate within Project Area** |
| **Sam Drew** | | | | | |
| Spring 2008 | 12 | 79 | 1 | 1 | 0.01 |
| Fall 2008 | 12 | 82 | 4 | 4 | 0.05 |
| Summer-Fall 2009 | 16 | 128 | 7 | 7 | 0.05 |
| Spring 2010 | 15 | 102.5 | 11 | 7 | 0.07 |
| Summer-Fal 2010 | 20 | 140 | 15 | 7 | 0.05 |
| **Total** | **75** | **531.5** | **38** | **26** | **0.05** |
| | | | | | |
| **Hunt Ridge** | | | | | |
| Spring 2010 | 15 | 101 | 20 | 11 | 0.11 |
| Summer-Fall 2010 | 20 | 140 | 13 | 7 | 0.05 |
| **Total** | **35** | **241** | **33** | **18** | **0.07** |
| | | | | | |
| **May Mountain** | | | | | |
| Summer-Fall 2009 | 15 | 106.5 | 7 | 0 | 0 |
| Spring 2010 | 3 | 21 | 0 | 0 | 0 |
| **Total** | **18** | **127.5** | **7** | **0** | **0.00** |
| | | | | | |
| **Overall Total** | **128** | **900** | **78** | **44** | **0.05** |

**Appendix B Table 2. Summary of Bald Eagle Observations during Spring and Fall 2008 Surveys**

| Date of Survey | Survey Location | Hours of Survey | Number of Individuals Observed | Obs # | Within project boundary? (yes or no) | Time | Age (J, Sub-A or A) | min height (m) A1 | max height (m) A1 | min height (m) A2 | max height (m) A2 | min height (m) A3 | max height (m) A3 | min height (m) B | max height (m) B | min height (m) C | max height (m) C | min height (m) D | max height (m) D | Flight Behavior (code) | Azimuth | Minutes over ridge below max turbine height | Other behavior notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5/1/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 5/2/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 5/7/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 5/9/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 5/10/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 5/13/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 5/14/2008 | Sam Drew | 7 | 1 | 1 | Y | 1:00-2:00 | sub A | | | | | | | | | 350 | 350 | 400 | 400 | S | SE | NA | flew from ponds south and west |
| 5/20/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 5/23/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 5/29/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 5/30/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 8/26/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 9/2/2008 | Sam Drew | 6 | 1 | 2 | Y | 11:12:00 | J | 80 | 80 | | | | | 150 | 150 | | | | | D | N | NA | |
| 9/3/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 9/11/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 9/17/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 9/18/2008 | Sam Drew | 7 | 1 | 3 | Y | 9:00-10:00 | A | | | | | | | | | 50 | 50 | 75 | 75 | I,D | SW | NA | adult moving southwest over fields/valley from the north |
| 9/29/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 9/30/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 10/9/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 10/10/2008 | Sam Drew | 7 | 2 | 4 | Y | 9:00-10:00 | A,SII | 50 | 75 | | | | | | | | | | | D | S | NA | both direct soaring over ridgeline to south |
| 10/13/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |
| 10/14/2008 | Sam Drew | 7 | | | | | | | | | | | | | | | | | | | | | |

**2008 Summary**

| | Number of Hours | Number of Eagles | Number of Eagles within Project Area | Total Passage Rate | Project Area Passage Rate |
|---|---|---|---|---|---|
| Sam Drew Spring | 79 | 1 | 1 | 0.01 | 0.01 |
| Sam Drew Fall | 82 | 4 | 4 | 0.05 | 0.05 |

**Appendix B Table 3. Summary of Bald Eagle Observations during Summer-Fall 2009 Surveys**

| Date of Survey | Survey Location | Hours of Survey | Number of Individuals Observed | Obs # | Within project boundary (yes or no) | Time | Age (J, Sub-A or A) | min height (m) A1 | max height (m) A1 | min height (m) A2 | max height (m) A2 | min height (m) A3 | max height (m) A3 | min height (m) B | max height (m) B | min height (m) C | max height (m) C | min height (m) D | max height (m) D | Flight Behavior (code) | Azimuth | Minutes over ridge below max turbine height | Other behavior notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/9/2009 | Sam Drew | 8 | 0 | | | | | | | | | | | | | | | | | | | | |
| 7/10/2009 | Sam Drew | 8 | 1 | 1 | Y | 10:00-11:00 | A | | | | | | | 50 | 50 | | | | | CS,LS | 45 | 0 | flying along slope of the eastern portion of the project to the north |
| 7/15/2009 | Sam Drew | 8 | 0 | | | | | | | | | | | | | | | | | | | | |
| 7/16/2009 | Sam Drew | 8 | 0 | | | | | | | | | | | | | | | | | | | | |
| 7/25/2009 | Sam Drew | 8 | 1 | 2 | Y | 12:00-1:00 | SubA | | | 50 | 50 | | | 75 | 75 | | | | | PF | 10 | 1 | flew right over north Met to the north |
| 7/31/2009 | Sam Drew | 8 | 0 | | | | | | | | | | | | | | | | | | | | |
| 8/14/2009 | Sam Drew | 8 | 1 | 3 | Y | 10:00-11:00 | SubA | | | 120 | 120 | | | 150 | 150 | | | | | LS/G | 330 | 1 | flew to the north doing semicircles then gliding over over ridgetop |
| 8/19/2009 | Sam Drew | 8 | 0 | | | | | | | | | | | | | | | | | | | | |
| 8/21/2009 | Sam Drew | 8 | 0 | | | | | | | | | | | | | | | | | | | | |
| 8/25/2009 | Sam Drew | 8 | 0 | | | | | | | | | | | | | | | | | | | | |
| 8/26/2009 | Sam Drew | 8 | 0 | | | | | | | | | | | | | | | | | | | | |
| 9/1/2009 | Sam Drew | 8 | 0 | | | | | | | | | | | | | | | | | | | | |
| 9/2/2009 | Sam Drew | 8 | 1 | 4 | Y | 10:00-11:00 | J | 30 | 150 | | | | | | | | | | | CS,LS | 300 | 3 | moving north along ridgeline, then along other ridgelines to north |
| 9/2/2009 | Sam Drew | | 1 | 5 | Y | 12:00-1:00 | A | 75 | 200 | | | | | 300 | 300 | | | | | CS,LS | 310 | 4 | circled on thermal above ridge to north before slowly moving north in thermal |
| 9/3/2009 | Sam Drew | 8 | 0 | | | | | | | | | | | | | | | | | | | | |
| 9/9/2009 | Sam Drew | 8 | 2 | 6 | Y | 3:00-4:00 | A | | | 500 | 500 | | | | | | | 800 | 800 | CS | 300 | 0 | circled over slope perpendicular to ridgeline in easterly direction and then changed direction and circled over valley |
| 9/10/2009 | Sam Drew | 8 | 0 | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 8/24/2009 | May Mtn | 8 | 1 | 1 | N | 8:00-9:00 | A | | | | | | | | | | | 50 | 100 | LS,PF,CF | NW | | flying low to the south; resident? mobbed by crows |
| 8/27/2009 | May Mtn | 8 | 0 | | | | | | | | | | | | | | | | | | | | |
| 9/1/2009 | May Mtn | 8 | 1 | 2 | N | 1:00-2:00 | A | | | | | | | | | | | 600 | 600 | CS | NE | | outside Project area |
| 9/2/2009 | May Mtn | 7 | 1 | 3 | N | 11:00-12:00 | J | | | | | | | | | | | 1,000 | 1,000 | LS,CS | SE | | circle-soared upward gaining altitude then linear soared to the southeast; migratory behavior |
| 9/9/2009 | May Mtn | 7 | 2 | 4 | N | 11:00-12:00 | A | | | | | | | | | 200 | 300 | | | LS | | | circling together, climbing very high while circling out of range of binoculars |
| 9/17/2009 | May Mtn | 7 | 0 | | | | | | | | | | | | | | | | | | | | |
| 9/18/2009 | May Mtn | 6.5 | 0 | | | | | | | | | | | | | | | | | | | | |
| 9/23/2009 | May Mtn | 7 | 0 | | | | | | | | | | | | | | | | | | | | |
| 9/24/2009 | May Mtn | 7 | 0 | | | | | | | | | | | | | | | | | | | | |
| 9/25/2009 | May Mtn | 7 | 1 | 5 | N | 10:00-11:00 | A | | | | | | | | | | | 100 | 100 | CS | N | | edge |
| 10/1/2009 | May Mtn | 7 | 0 | | | | | | | | | | | | | | | | | | | | |
| 10/2/2009 | May Mtn | 6 | 0 | | | | | | | | | | | | | | | | | | | | |
| 10/8/2009 | May Mtn | 7 | 1 | 6 | N | 10:00-11:00 | A | | | | | | | | | | | 150 | 500 | G,CS | | | passed over ridge separating lakes; outside project area |
| 10/9/2009 | May Mtn | 7 | 0 | | | | | | | | | | | | | | | | | | | | |
| 10/16/2009 | May Mtn | 7 | 0 | | | | | | | | | | | | | | | | | | | | |

**2009 Summer-Fall Summary**

| | Number of Hours | Number of Eagles | Number of Eagles within Project Area | Total Passage Rate | Project Area Passage Rate |
|---|---|---|---|---|---|
| Sam Drew | 128 | 7 | 7 | 0.05 | 0.05 |
| May Mtn | 106.5 | 7 | 0 | 0.07 | 0.00 |

**Appendix B Table 4. Summary of Bald Eagle Observations during Winter-Spring 2010 Surveys**

| Date of Survey | Observer | Survey Location | Hours of Survey | Number of Individuals Observed | Obs # | Within project boundary (yes or no) | Time | Species | Age (J, Sub-A or A) | min height (m) A1 | max height A1 (m) | min height (m)A2 | max height (m)A2 | min height (m) A3 | max height (m) A3 | min height (m) B | max height (m) B | min height (m) C | max height (m) C | min height (m) D | max height (m) D | Flight Behavior (code) | Azimuth | Minutes over ridge below max turbine height | Ridge Time (min) | Other behavior notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/17/2010 | SPM | Sam Drew | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 4/13/2010 | PRB | Sam Drew | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 4/14/2010 | SPM | Sam Drew | 7 | 1 | 1 | N | 2:00-3:00 | BAEA | A | | | | | | | | | | | 1500 | 2000 | CS | N | | | circle-soared on thermals over Higgins Brook Valley, north around ridge |
| 4/20/2010 | PRB | Sam Drew | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 4/23/2010 | PRB | Sam Drew | 6 | 1 | 2 | Y | 10:00-11:00 | BAEA | A | | | 210 | 210 | | | | | | | 450 | 450 | CS | ? | 0:00 | 0:15 | high circling over Hunt Mountain southwest; lost and could not observe direction of travel |
| 4/27/2010 | PRB | Sam Drew | 7 | 1 | 3 | Y | 10:00-11:00 | BAEA | A | 310 | 350 | | | | | 350 | 350 | 350 | 350 | 350 | 350 | CS, G | SSW | 0:00 | 0:45 | high over Hunt Mountain south; circling and moving in high glide well to south; may be 143-nest bird? circling high despite poor conditions for thermal development |
| 4/27/2010 | PRB | Sam Drew | | 1 | 4 | N | 1:00-2:00 | BAEA | A | | | | | | | | | 300 | 350 | 350 | 500 | CS, G | SSW | n/a | 0:00 | moving south, high over valley (may have crossed south end of Sam Drew Mountain) |
| 4/27/2010 | PRB | Sam Drew | | 2 | 5 | N | 2:00-3:00 | BAEA | A | | | | | | | | | | | 450 | 450 | G | NE | n/a | 0:00 | flying with osprey, well to north in Medux Region, gliding away |
| 5/7/2010 | PRB | Sam Drew | 6.5 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 5/11/2010 | PRB | Sam Drew | 6.5 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 5/17/2010 | PRB | Sam Drew | 7 | 1 | 6 | Y | 2:00-3:00 | BAEA | A | | | 60 | 70 | | | 120 | 120 | 150 | 150 | 250 | 375 | CS, PF, G | NNW | :05 | :05 | high circle over Phase I; glide north; Mattawamkeag Lake pair bird? |
| 5/17/2010 | PRB | Sam Drew | 7 | 1 | 7 | Y | 2:00-3:00 | BAEA | SAII | 35 | 35 | | | | | 20 | 40 | | | | | G | NE | :25 | :25 | moving north shortly after adult, much lower in elevation |
| 5/22/2010 | PRB | Sam Drew | 7 | 1 | 8 | Y | 10:00-11:00 | BAEA | A | | | | | | | 70 | 90 | 100 | 250 | 250 | 250 | G | SSW | :00 | :00 | up from Higgins and south-southwest toward Mattawamkeag Lake (just outside project area) |
| 5/22/2010 | PRB | Sam Drew | | 2 | 9 | Y | 11:00-12:00 | BAEA | A | | | 500 | 500 | | | 500 | 500 | 500 | 500 | 210 | 550 | CS, AD, G | SE | :00 | :40 | cross Hunt Mountain and very high aerial displays (Matta pair) |
| 5/24/2010 | PRB | Sam Drew | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 5/25/2010 | PRB | Sam Drew | 6.5 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 5/26/2010 | PRB | Sam Drew | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 5/28/2010 | SPM | Sam Drew | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3/18/2010 | SPM | Hunt | 5 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 4/2/2010 | SPM | Hunt | 6 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 4/14/2010 | PRB | Hunt | 7 | 1 | 1 | Y | 11:00-12:00 | BAEA | SAIV | 60 | 100 | | | | | | | | | | | PF, G, HO | var | :20 | 1:30 | moving south from Higgins to met clearing; hovered and moved back north to Medux |
| 4/14/2010 | PRB | Hunt | | 1 | 2 | Y | 2:00-3:00 | BAEA | A | | | 75 | 125 | | | 100 | 400 | 250 | 250 | 250 | 250 | CS, G | W | :45 | :45 | moved west; sim ID |
| 4/14/2010 | PRB | Hunt | | 1 | 3 | N | 3:00-4:00 | BAEA | A | | | | | | | | | | | 300 | 750 | CS, G | NE | | | same as #9? |
| 4/19/2010 | PRB | Hunt | 7 | 2 | 4 | N | 2:00-3:00 | BAEA | A | | | | | | | | | | | 175 | 450 | CS, G | SE | | | high circle over Higgins, one bird higher, glides down to second; both birds descend out of sight |
| 4/22/2010 | PRB | Hunt | 7 | 1 | 5 | Y | 10:00-11:00 | BAEA | A | | | 70 | 110 | | | 225 | 225 | 300 | 300 | 200 | 550 | CS, PF, G | | | | |
| 4/22/2010 | PRB | Hunt | | 1 | 6 | N | 12:00-1:00 | BAEA | A | | | | | | | | | | | 100 | 375 | CS, AD, D | | | | |
| 4/22/2010 | PRB | Hunt | | 1 | 7 | Y | 1:00-2:00 | BAEA | A | 150 | 150 | | | | | 100 | 350 | 100 | 350 | 100 | 350 | CS, G | | | | |
| 4/22/2010 | PRB | Hunt | | 2 | 8 | N | 2:00-3:00 | BAEA | A | | | | | | | | | | | 175 | 350 | CS, G | | | | |

**Appendix B Table 4. Summary of Bald Eagle Observations during Winter-Spring 2010 Surveys**

| Date of Survey | Observer | Survey Location | Hours of Survey | Number of Individuals Observed | Obs # | Within project boundary (yes or no) | Time | Species | Age (J, Sub-A or A) | min height (m) A1 | max height A1 (m) | min height (m)A2 | max height (m)A2 | min height (m) A3 | max height (m) A3 | min height (m) B | max height (m) B | min height (m) C | max height (m) C | min height (m) D | max height (m) D | Flight Behavior (code) | Azimuth | Minutes over ridge below max turbine height | Ridge Time (min) | Other behavior notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4/26/2010 | PRB | Hunt | 7 | 1 | 9 | N | 9:00-10:00 | BAEA | unkn | | | | | | | | | | | 350 | 350 | CS, G | NE | n/a | 0:00 | long-distance observation; lost quickly below trees |
| 4/26/2010 | PRB | Hunt | | 1 | 10 | Y | 10:00-11:00 | BAEA | J | | | 100 | 220 | | | | | 100 | 300 | | | CS, PF, G | SSE | 0:35 | 1:00 | juvenile of unknown age (backlit and trees, not adult); relatively low flight south-southeast over ridge |
| 4/26/2010 | PRB | Hunt | | 1 | 11 | N | 1:00-2:00 | BAEA | A | | | | | | | | | | | 150 | 590 | CS | NNW | n/a | 0:00 | high circle to north; moving away north-northwest; in thermal with osprey |
| 4/30/2010 | PRB | Hunt | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 5/2/2010 | PRB | Hunt | 7 | 1 | 12 | Y | 10:00-11:00 | BAEA | SA II | | | 65 | 75 | | | 60 | 150 | 100 | 175 | | | CS, G | SW | 0:35 | 0:35 | lifting up over Morrison area and crossing Hunt Ridge |
| 5/2/2010 | PRB | Hunt | | 1 | 13 | N | 10:00-11:00 | BAEA | A | | | | | | | | | | | 200 | 450 | CS, G | W | n/a | 0:00 | high circle and glide away to west (toward Timony and Spaulding Lakes) |
| 5/2/2010 | PRB | Hunt | | 2 | 14 | Y | 10:00-11:00 | BAEA | A | 85 | 160 | 45 | 45 | | | | | | | 100 | 300 | CS, AD, G | SW | 2:10 | 3:50 | one eagle moving in from south; both circle over Higgins and back south; see map |
| 5/2/2010 | PRB | Hunt | | 1 | 15 | Y | 11:00-12:00 | BAEA | unkn | | | 100 | 115 | | | | | | | | | PF, G | W | 0:15 | 0:15 | |
| 5/2/2010 | PRB | Hunt | | 1 | 16 | Y | 3:00-4:00 | BAEA | A | | | 175 | 175 | | | 100 | 300 | 150 | 300 | 150 | 300 | CS, G | SW | 4:20 | 0:40 | circle Higgins Brook, cross Hunt Mountain north and move south toward Skitacook |
| 5/3/2010 | PRB | Hunt | 6.5 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 5/16/2010 | PRB | Hunt | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 5/18/2010 | PRB | Hunt | 7 | 1 | 17 | Y | 2:00-3:00 | BAEA | A | 270 | 350 | | | | | 325 | 325 | 325 | 325 | 325 | 325 | CS, G | NE | :00 | 3:45 | high circle on thermal over Hunt Ridge; glides away toward Medux |
| 5/20/2010 | PRB | Hunt | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 5/23/2010 | PRB | Hunt | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 5/24/2010 | SPM | Hunt | 6.5 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 5/27/2010 | SPM | Hunt | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3/16/2010 | SPM | May Mtn | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 4/1/2010 | SPM | May Mtn | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 4/13/2010 | SPM | May Mtn | 7 | 0 | | | | | | | | | | | | | | | | | | | | | | |

| 2010 Winter Spring Summary | | | | | |
|---|---|---|---|---|---|
| | **Number of Hours** | **Number of Eagles** | **of Eagles within Project Area** | **Total Passage Rate** | **Project Area Passage Rate** |
| Sam Drew | 102.5 | 11 | 7 | 0.11 | 0.07 |
| Hunt | 101 | 20 | 11 | 0.20 | 0.11 |
| May Mtn | 21 | 0 | 0 | 0.00 | 0.00 |

**Appendix B Table 5. Summary of Bald Eagle Observations during Summer-Fall 2010 Surveys**

| Date of Survey | Observer | Survey Location | Number of Individuals | | Within project boundary (yes or no) | Time | Species | Age (J, Sub-A or A) | min height (m) A1 | max height A1 (m) | min height (m)A2 | max height (m)A2 | min height (m) A3 | max height (m) A3 | min height (m) B | max height (m) B | min height (m) C | max height (m) C | min height (m) D | max height (m) D | Flight Behavior Code | Minutes over ridge below max turbine height | Behavioral notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/18/2010 | SPM | Sam Drew | | | | | NO EA | | | | | | | | | | | | | | | | |
| 7/7/2010 | NED | Sam Drew | | | | | NO EA | | | | | | | | | | | | | | | | |
| 7/20/2010 | SAB | Sam Drew | 1 | | N | 12:00-1:00 | BAEA | A | | | | | | | | | 90 | 100 | | | CS, LS | | only glimpsed; low down in valley; chased and dived at by unidentified buteo |
| 7/26/2010 | JLC | Sam Drew | | | | | NO EA | | | | | | | | | | | | | | | | |
| 7/27/2010 | NED | Sam Drew | | | | | NO EA | | | | | | | | | | | | | | | | |
| 8/10/2010 | PRB | Sam Drew | 1 | | N | 10:00-11:00 | BAEA | A | | | | | | | | | | | 200 | 900 | CS, G | | well outside project area; circling high in big thermal, being chased by unidentified raptor over Skitacook area moving away southwest |
| 8/11/2010 | NED | Sam Drew | | | | | NO EA | | | | | | | | | | | | | | | | |
| 8/24/2010 | NED | Sam Drew | 1 | | Y | 2:00-3:00 | BAEA | A | 80 | 350 | | | | | 80 | 100 | | | | | G, CS | 2:45 | first seen flying northeast along ridge just to southeast of observation site, then flew down below treeline. within 30 minutes bird was seen circle-soaring over ridge climbing up to a height of ~350 m then gliding off to the northeast until it was beyond visible range with 10x binoculars. |
| 8/31/2010 | PRB | Sam Drew | | | | | NO EA | | | | | | | | | | | | | | | | |
| 9/1/2010 | LSC | Sam Drew | | | | | NO EA | | | | | | | | | | | | | | | | |
| 9/13/2010 | NED | Sam Drew | 1 | | Y | 10:00-11:00 | BAEA | J | 30 | 150 | | | | | | | | | | | G, CS | 1:10 | moving along ridge at about 30-50m then climbing and continued off to southwest |
| 9/15/2010 | LSC | Sam Drew | 1 | | N | 11:00-12:00 | BAEA | J | | | | | | | | | | | 100 | 150 | PF | | observed for a fraction of a second being attacked by a raven |
| 9/16/2010 | NED | Sam Drew | 1 | | N | 10:00-11:00 | BAEA | A | | | | | | | 40 | 50 | 50 | 100 | | | LS, G | | linear soaring along northwest of ridge; brief glimpse through trees |
| 10/4/2010 | JSP | Sam Drew | 1 | | Y | 2:00-3:00 | BAEA | SA | | | | | 75 | 150 | | | | | | | LS | 0:10 | |
| 10/5/2010 | LSC | Sam Drew | 1 | | Y | 1:00-2:00 | BAEA | A | 200 | 300 | | | | | 200 | 300 | 300 | 400 | 300 | 400 | LS | 0:00 | may not be migrating, could be a local because of the local nests. very far away and difficult to see. clearly an adult. |
| 10/6/2010 | JSP | Sam Drew | 1 | | N | 12:00-1:00 | BAEA | SA | | | | | | | 25 | 80 | | | | | LS | | |
| 10/8/2010 | JSP | Sam Drew | | | | | NO EA | | | | | | | | | | | | | | | | |
| 10/12/2010 | LSC | Sam Drew | 1 | | Y | 12:00-1:00 | BAEA | U | | | 150 | 200 | | | 200 | 250 | | | | | CS | 0:00 | too far away to be sure of age; may be an adult; flew very high in wide circles |
| 10/12/2010 | LSC | Sam Drew | 1 | | Y | 12:00-1:00 | BAEA | A | 300 | 350 | | | | | 300 | 350 | 350 | 400 | 400 | 450 | CS,G | 0:00 | bald eagle may be observation #4 reappearing; an adult. Flew very high in wide circles and glided north, then joined by three unknown raptors. Two may have been buteos, the other may be an adolescent eagle. All four had the same flight path. The unknown raptor which may be another eagle dive bombed the eagle a couple of times. |
| 10/13/2010 | LSC | Sam Drew | | | | | NO EA | | | | | | | | | | | | | | | | |
| 10/14/2010 | JSP | Sam Drew | 1 | | N | 12:00-1:00 | BAEA | A | | | | | | | | | | | 300 | 400 | LS | | |
| 10/14/2010 | JSP | Sam Drew | 1 | | N | 12:00-1:00 | BAEA | A | | | | | | | | | | | 250 | 300 | LS | | |
| 10/14/2010 | JSP | Sam Drew | 1 | | Y | 2:00-3:00 | BAEA | SA | 150 | 450 | | | | | | | | | | | LS | 0:00 | |
| 10/14/2010 | JSP | Sam Drew | 1 | | N | 2:00-3:00 | BAEA | SA | | | | | | | | | 200 | 350 | | | G | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 6/17/2010 | SPM | Hunt | | | | | NO EA | | | | | | | | | | | | | | | | |
| 7/7/2010 | SPM | Hunt | | | | | NO EA | A | | | | | | | | | | | | | | | |
| 7/20/2010 | NED | Hunt | | | | | NO EA | | | | | | | | | | | | | | | | |
| 7/26/2010 | NED | Hunt | | | | | NO EA | | | | | | | | | | | | | | | | |
| 7/27/2010 | JLC | Hunt | | | | | NO EA | | | | | | | | | | | | | | | | |
| 8/10/2010 | NED | Hunt | | | | | NO EA | | | | | | | | | | | | | | | | |
| 8/11/2010 | PRB | Hunt | | | | | NO EA | | | | | | | | | | | | | | | | |
| 8/24/2010 | LSC | Hunt | 1 | | Y | 2:00-3:00 | BAEA | A | 80 | 350 | | | | | 80 | 100 | | | | | G, CS | 2:45 | |
| 8/31/2010 | LSC | Hunt | | | | | NO EA | | | | | | | | | | | | | | | | |
| 9/1/2010 | NED | Hunt | | | | | NO EA | | | | | | | | | | | | | | | | |
| 9/13/2010 | LSC | Hunt | 1 | | Y | 10:00-11:00 | BAEA | J | 30 | 150 | | | | | | | | | | | G, CS | | |
| 9/15/2010 | NED | Hunt | 1 | | Y | 11:00-12:00 | BAEA | A | | | | | 80 | 100 | 100 | 200 | 200 | 230 | | | PF, CS, G | | from ridge to west, flew to valley between observation locations; circle-soared a few times moving back toward Hunt then off to the northeast |
| 9/15/2010 | NED | Hunt | 1 | | N | 11:00-12:00 | BAEA | A | | | | | | | 130 | 160 | 160 | 180 | | | LS | | escorted by two common ravens; steady flight along slope to northeast |
| 9/15/2010 | NED | Hunt | 1 | | Y | 11:00-12:00 | BAEA | J | | | | | | | 150 | 180 | 180 | 250 | | | PF | 0:00 | harassed by common ravens and chased all over |
| 9/16/2010 | LSC | Hunt | 1 | | N | 9:00-10:00 | BAEA | J or SA | | | | | | | | | 80 | 90 | 80 | 100 | LS, G | | too far away to determine if it was a juvenile or sub adult; not an adult. hardly flapped. watched for 5 minutes before it was too far to see. does not appear to be migrating; gliding the whole time over the valley and used the updrafts near ridge to linear soar |
| 9/16/2010 | LSC | Hunt | 1 | | Y | 1:00-2:00 | BAEA | A | | | 50 | 60 | | | 60 | 70 | 70 | 80 | 80 | 100 | G, CS | | attacked by a raven; flying high up to the east. no flapping |
| 9/17/2010 | LSC | Hunt | | | | | NO EA | | | | | | | | | | | | | | | | |
| 10/4/2010 | LSC | Hunt | | | | | NO EA | | | | | | | | | | | | | | | | |
| 10/5/2010 | JSP | Hunt | | | | | NO EA | | | | | | | | | | | | | | | | |
| 10/6/2010 | LSC | Hunt | 1 | | N | 12:00-1:00 | BAEA | SA | | | | | | | 25 | 80 | | | | | LS | | see JSP data for observation # 4 BAEA. observed bird at a great distance and JSP called to see if it was visible simultaneously. observed for an instant; not enough time to gather data |
| 10/8/2010 | LSC | Hunt | 1 | | N | 10:00-11:00 | BAEA | A | | | | | | | 20 | 25 | 30 | 50 | 40 | 70 | LS,CS,G | 0:00 | flying near three ravens which may have been harassing it. flew low over Drew Mountain and disappeared over the ridge; may be a local from Drew's Lake (Medunknekeag Lake) nests or could be migrating |
| 10/8/2010 | LSC | Hunt | 1 | | Y | 3:00-4:00 | BAEA | A | 30 | 70 | | | | | | | | | | | PF, LS | 0:00 | flying away from a group of ravens. may be observation #1 reappearing and therefore may not be migrating. lost sight while flying along the ridge with trees behind it |
| 10/13/2010 | JSP | Hunt | | | | | NO EA | | | | | | | | | | | | | | | | |
| 10/14/2010 | LSC | Hunt | 1 | | Y | 12:00-1:00 | BAEA | A | | | 20 | 25 | | | 50 | 70 | 70 | 90 | 120 | 300 | CS,G | 6:00 | observation #2 joined by observation # 3 after four minutes as indicated on the map. Both circle-soared higher and higher over the valley then gliding in the direction of Meduknekeag Lake; separating eventually as shown on map. |
| 10/14/2010 | LSC | Hunt | 1 | | Y | 12:00-1:00 | BAEA | A | | | 20 | 25 | | | 50 | 70 | 70 | 90 | 120 | 300 | CS,G | 2:00 | |
| 10/14/2010 | LSC | Hunt | 1 | | Y | 2:00-3:00 | BAEA | SA | 120 | 150 | 200 | 300 | | | 200 | 220 | 220 | 250 | 250 | 300 | LS,CS,G | 0:00 | distance and cloud backdrop made determining the age difficult. Also observed by JSP and thought to be a sub-adult. Not one of the adults observed previously; did not fly towards Meduknekeag Lake. |

**2010 Summer Fall Summary**

| | Number of Hours | Number of Eagles | Number of Eagles within Project Area | Total Passage Rate | Project Area Passage Rate |
|---|---|---|---|---|---|
| Sam Drew | 140 | 15 | 7 | 0.11 | 0.05 |
| Hunt | 140 | 13 | 7 | 0.09 | 0.05 |

# Appendix C
# Summary of Best Available Information about Interaction between Bald Eagles and Wind Turbines

*Raptor and Bald Eagle Mortality at Existing Wind Facilities*

Available information on the mortality of raptors, including eagles, from wind facilities include: results of post-construction mortality surveys in the US; comparison of site-characteristics of facilities with high numbers of fatalities in other countries; and results of surveys conducted pre- and post-construction at the same facilities.

The potential collision risk to bald eagles from wind facilities is influenced by the eagles' use of the ridgeline topography to catch updrafts for soaring, as well as potential crossing of the ridgeline during foraging. Outside of previous and ongoing studies at California's Altamont Pass, publicly-available studies of mortality at operating wind farms have consistently documented exceptionally low raptor mortality rates throughout North America. Conversely, the historic cause and effect of raptor mortality at Altamont is well documented (Smallwood and Thelander 2007, GAO 2005). Mortality rates found at onshore wind developments, outside of Altamont, documented 0 to 0.07 raptor fatalities/turbine/year from 2000-2004 (GAO 2005). A subsequent technical review of wind energy impacts by The Wildlife Society (Arnett et al. 2007) documented a combined mean rate of 0.03 raptors per turbine at operating wind farms. Each of the studies incorporated in The Wildlife Society review integrated scavenger removal and searcher efficiency biases. At 14 wind projects in the US (outside California), over 15,000 turbine searches have been conducted over a 15-year period. Less than 50 raptor fatalities have been reported (Table 3-1; 1994-2009); none of which were bald eagles.

Species found during the mortality searches were common to the area and occurred during both migratory and breeding seasons. Despite regular and ongoing reviews, there have not been any bald eagle fatalities reported at an operating wind facility in the US (Erickson and Arnett 2008).[1],[2]

In addition to reported fatalities at sites in the US, fatalities of related eagle species have been documented at several facilities outside the US. As part of this review, Stantec investigated fatalities of eagle species closely related to the bald eagle, such as the sea eagle *(Haliaeetus albicilla)* and wedge-tailed eagle *(Aquila audax)*. Fatalities appear to be most common in settings that are inherently far more risky than this Project area. For example, most of these facilities are located in coastal areas close to, and in one case, surrounding, high densities of breeding and resident eagles. Facilities in Norway, Australia, and Japan also include much larger numbers of turbines than are proposed at this project (Table 3-2).

[1] As of March 2010, two reports of bald eagle fatality have been documented in Canada associated with a wind facility. In November 2004, an adult bald eagle was recovered by facility personnel at the Castle River Wind Farm in southern Alberta. The cause of death was not determined, but the bird was found between two adjacent turbines. This facility includes 66 older-style turbines located in cultivated fields or heavily grazed native pasture; these turbines are spaced 100-150 meters apart and have a maximum height of 73 m, compared to 120 to 150 m for modern turbines. In June 2009, anecdotal reports of a fatality of a bald eagle were reported at a wind facility in Ontario. However, no information is currently publicly available for this incident. The facility includes 66 turbines and is within two miles of Lake Erie in a well-documented fall raptor migration corridor. A Hawk Watch site within 20 miles averages 37,000 raptors per fall season.

[2] Due to differences in turbine and monopole (tower) type, design, spacing, and rotor speed, along with differences in raptor use, the patterns of raptor fatality in California are considered unique among US installations, particularly when compared with results at facilities with modern turbine designs.

**Table 3-1.** Available raptor mortality data reported at wind farms in the U.S. (outside of California) from 1994-2009

| Location | Habitat Type (# Turbines) | Study period | Search Interval | Number of fatalities and species | Dates of carcass discovery | Reference |
|---|---|---|---|---|---|---|
| Buffalo Ridge, MN | agricultural grassland (73) | 1994-1995 | 30-50 weekly | 0 | n/a | Osborn *et al.* 2000 |
| Buffalo Ridge, MN | agricultural grassland (138) | 1996-1999 | 30 per 14 days | 1 red-tailed hawk | n/a | Johnson *et al*. 2002 |
| Searsburg, VT | forested ridge (11) | 1997 | 11 total (4 per search) 2-6 days per month | 0 | n/a | Kerlinger 2002 |
| Foote Creek Rim, WY | shrub-steppe grassland (69) | 1998-2002 | 35 searched once every 2 weeks | 1 northern harrier, 3 American kestrel, 1 short-eared owl | Northern harrier (4/19/99); American kestrel (5/12/99, 10/12/99, 7/19/00); short-eared owl (09/28/00) | Young *et al.* 2003 |
| Vansycle, Umatilla County, Oregon | agricultural grassland (38) | 1999 | All turbines searched each 28-day period | 0 | n/a | Erickson *et al.* 2000 |
| Stateline, WA/OR | agricultural grassland (454) | 2001-2003 | 120-150 total | 9 red-tailed hawk, 3 American kestrel, 1 ferruginous hawk, 1 Sawinson's hawk, 1 short-eared owl | Total raptor fatalities 2002: 1 in June, 2 in August, 2 in September, and 1 in October; 2003: 1 in May, 1 in June, 3 in July, 2 in October | Erickson *et al.* 2004 |
| Somerset County, PA | agricultural grassland (8) | 2000 | n/a | 0 | n/a | Kerlinger 2006 |
| Nine Canyon, WA | shrub-steppe grassland (37) | 2002-2003 | 1 x 2 weeks | 1 American kestrel, 1 short-eared owl | American kestrel (11/18/02), short-eared owl (4/7/03) | Erickson *et al.* 2003 |
| Klondike, OR | shrub-steppe grassland (16) | 2002-2003 | 1 x month | 0 | n/a | Johnson et al. 2003 |
| Mountaineer, WV | forested ridge (44) | 2003 | 2 x per week | 1 red-tailed hawk, 2 turkey vultures | each between 04/04/03 - 04/27/03, 06/02/03 -06/24/03, 07/28/03 - 07/29/03, and 08/18/03 - 11/22/03 | Kerns and Kerlinger 2004 |
| Mountaineer, WV | forested ridge (44) | 2004 | 22 daily, 22 weekly | 1 sharp-shinned hawk, 1 turkey vulture | both between 07/31/04 - 09/11/04 | Arnett *et al* 2005 |
| Meyersdale, PA | forested ridgeline (20) | 2004 | 10 daily, 10 weekly | 0 | n/a | Arnett *et al.* 2005 |
| Top of Iowa, Iowa | agricultural grassland (89) | 2004 | 26 every 3 days | 1 red-tailed hawk | red-tailed hawk (4/01/04 - 12/10/04) | Koford *et al*. 2005 |
| Buffalo Mountain, TN | open/shrubland (18) | 2005 | 18 of 18 every week, every 2 weeks, or every 2-5 days | 0 | n/a | Fiedler *et al*. 2007 |
| Kewaunee County, Wisconsin | agricultural grassland (31) | 1999-2001 | | 0 | n/a | Howe *et al.* 2002 |
| Maple Ridge, NY | woodland, agricultural grassland (120) | 2006 | 10 every 3 days, 30 7 days, 10 daily | 1 American kestrel | American kestrel (7/06) | Jain *et al*. 2007 |
| Maple Ridge, NY | woodland, agricultural grassland (195) | 2007 | 64 weekly | 1 American kestrel, 5 red-tailed hawk | red-tailed hawk (1 found 8/07, 2 found 9/07) // (1 sharp-shinned hawk and 2 red-tailed hawk dates not reported) | Jain et al. 2008 |
| Maple Ridge, NY | woodland, grassland, agricultural (120) | 2008 | 64 weekly | 1 American kestrel, 2 sharp-shinned hawk, 1 Cooper's hawk | n/a | Jain *et al.* 2009a |
| Mars Hill, ME | forested ridgeline (28) | 2007 | 2 of 28 daily, 28 of 28 weekly, seasonal dog searches | 0 | n/a | Stantec 2008 |
| Mars Hill, ME | forested ridgeline (28) | 2008 | 28 of 28 weekly, seasonal dog searches | 1 barred owl | barred owl (4/11/08) | Stantec 2009 |
| Mt. Storm, WV | forested ridgeline (82) | 2008 | 18 weekly, 9 daily | 2 turkey vulture | 9/25/2008 and 10/13/2008 | Young *et al*. 2009 |
| Lempster, NH | forested ridgeline (12) | 2009* | 4 daily | 0 | n/a | Tidhar 2009 |
| Clinton, NY | agricultural, woodland (67) | 2008 | 8 daily, 8 every 3-days, 7 every 7-days | 1 broad-winged hawk | May | Jain et al. 2009b |
| Ellenburg, NY | agricultural, woodland (54) | 2008 | 6 daily, 6 every 3-days, 6 every 7-days | 1 broad-winged hawk | June | Jain et al. 2009c |
| Bliss, NY | agricultural, woodland (67) | 2008 | 8 daily, 8 every 3-days, 7 every 7-days | 3 red-tailed hawk, 1 sharp-shinned hawk | 1 fatality in June, 1 fatality in August (2 incidental raptor dates not reported) | Jain et al. 2009d |
| Stetson, ME | forested ridgeline (38) | 2009 | 19 weekly | 1** | red-tailed hawk (7/27/09) | Stantec 2009b |
| Cohocton and Dutch Hill, NY | agricultural (50) | 2009 | 5 daily, 12 weekly | 1 | sharp-shinned hawk (7/8/09) | Stantec 2009c |
| Munnsville, NY | agricultural (23) | 2008 | 12 weely | 2 | red-tailed hawk (7/16 and 8/14) | Stantec 2009d |

*Results of spring interim report, study period April 20 to June 1.

**Fatality was result of electrocution at a riser pole of the electrical collection system

**Table 3-2**. Comparison of known eagle mortality factors at wind facilities outside United States

| Site | Landscape Conditions | Mortality | Site characteristics which influence mortality |
|---|---|---|---|
| Smola, Norway | coastal island | 36 white-tailed sea eagles between 2005 and 2010 | 68 turbines located in area identified as International Bird Area with the highest density of white-tailed sea eagles in the world (300 individuals, 86 breeding pairs, 13-16 pairs within facility area prior to operation). The relatively small, off-shore island essentially lacks tree or shrub vegetation and consequently supports a high concentration of eagles which nest on the ground directly within the rows of turbine strings. |
| Tarifa, Spain | near the Straits of Gibraltar | 2 short-tailed eagles over 1-year survey period (1993-1994) | Nearly 700 turbines (including lattice-tower models similar to Altamont) are located near a main point of migratory passage for several hundred thousand raptors annually. |
| Woolnorth, Tasmania | coastal bluff | 14-18 wedge-tailed eagles between 2003 and 2008 | 62 turbines located on costal bluff and wedge-tailed eagle nests are located within 0.3 miles of turbines. |
| Starfish, Australia | coastal bluff | 2 wedge-tailed sea eagles in 2004 | 23 turbines situated on a high coastal bluff |
| Hokkaido, Japan | coastal island | 6 white-tailed sea eagles from 2004-2007 | Almost 250 turbines are located in coastal area, along important migration route for sea eagles. |

Note: This information is based on a literature review of mortality events from various sources. Mortality of white-tailed sea eagles has also been reported at facilities in Germany and Sweden, but very limited information is available; a request for further details has been submitted. Reports of other mortality were either not facility-specific or could not be substantiated thru an extensive search of news articles, peer-reviewed literature and general web searches.

There are currently three sites in the Northeast for which pre- and post-construction raptor survey data and mortality data are available: 1) Maple Ridge Wind Project in Lewis County, NY (pre-construction surveys formerly referred to site as Harrisburg; 2) Mars Hill Wind Project in Aroostook County, ME; and 3) Lempster Wind Project in Sullivan County, NH. Post-construction raptor surveys were performed during the same year as mortality surveys in 2009 at the Stetson Wind Project in Penobscot and Washington Counties, ME. Raptor avoidance behaviors were observed at this site.

At Maple Ridge, NY, pre-construction surveys in fall 1998 documented a total of 554 raptors during 68 total hours of survey from the beginning of September to October (seasonal passage rate of 8.1 birds/hour). The most commonly observed raptor species during the pre-construction surveys were turkey vulture (n=294) and American kestrel (n=84). There were two New York state listed species observed, osprey (n=2) and northern harrier (n=52). The mean flight height of raptors was 48 m above ground level (Cooper and Mabee 1999), which is below the rotor swept area of the turbines. Two years

of post-construction mortality searches at Maple Ridge indicated relatively low raptor mortality, with an estimate of 0.07 American kestrels/turbine/year in 2006 (Jain et al. 2007), and an estimate of 0.41 red-tailed hawks per turbine per year in 2007 (Jain et al. 2008). No eagle fatalities were documented during post-construction surveys at the project.

At Mars Hill, ME, pre-construction surveys in fall 2005, documented a total of 115 raptors during 42.5 hours of survey from the beginning of September to mid-October (the seasonal passage rate was 1.52 birds/hour); spring 2006 results included a total of 64 raptors during 60.25 hours of survey between mid-April and late May (seasonal passage rate of 1.06 birds/hour). The most commonly observed raptor species during the fall surveys were sharp-shinned hawk (n=40) and red-tailed hawk (n=26) and, during the spring surveys were osprey (n=22) and turkey vulture (n=11). Maine state listed species observed included peregrine falcon (n=2, fall), and bald eagle (n=8, fall; n=4, spring). The seasonal percentage of birds below the maximum rotor-swept height of 120 meters (m) was 42 percent in the fall and 48 percent in the spring (Stantec 2008). Two years of concurrent raptor behavior and post-construction fatality surveys at Mars Hill were subsequently conducted in 2007 and 2008 to help characterize raptor use of the site during active operations. These observations indicated a continued use of the project area by a variety of migrant and resident raptors, including bald eagle, with documentation of direct turbine avoidance. These observations, correlated with minimal raptor fatalities (one owl fatality in two years of study, and that could have been a natural winter kill during the severe 2007-2008 winter conditions), strongly suggest a low raptor collision risk despite continued use of the area by raptors (Stantec 2008, Stantec 2009). No eagle fatalities were documented during post-construction surveys at the project.

At Lempster, NH, pre-construction surveys in fall 2005, documented a total of 264 raptors during 80 hours of survey (the seasonal passage rate was 3.3 birds/hour); spring 2006 results included a total of 102 raptors between mid-April and late May (seasonal passage rate of 1.3 birds/hour). The most commonly observed raptor species during the fall surveys were broad-winged hawk (n=170) and sharp-shinned hawk (n=49) and, during the spring surveys again were broad-winged hawk (n=39) and sharp-shinned hawk (n=20). The seasonal percentage of birds below the maximum rotor-swept zone was 60 percent in the fall and 56 percent in the spring (Woodlot 2007). One year of post-construction fatality surveys at Lempster were subsequently conducted in 2009 to determine the estimates of the overall annual mortality rate of the project. This monitoring did not cover raptor use of the project area after construction; however it did document species specific fatalities with adjustments for searcher efficiency and scavenger removal rates (Tidhar 2009). No raptor fatalities were documented during 2009 post-construction surveys at the project.

At Stetson, ME, post-construction raptor surveys occurred in conjunction with the post-construction mortality surveys. A total of 79 raptors (34 in spring; 45 in fall) during 70 hours of survey were observed for both spring and fall survey seasons (Stantec 2009b). The seasonal passage rate was 1.13 birds/hour. The most commonly observed raptor species were red-tailed hawk (n=26) and turkey vulture (n=19). The seasonal percentage of birds below the maximum turbine height was 67 percent for the spring and fall surveys combined. During post-construction mortality surveys, one red-tailed hawk was found, however it was electrocuted by a riser pole of the electrical collection system. No raptor fatalities were documented under turbines.

*Flight Behaviors*

Available information on the flight behavior of eagles and interaction with wind turbines includes results of behavior surveys conducted at multiple facilities, reported avoidance rates, and evaluation of factors that contribute to specific flight behaviors.

At proposed (and now existing) wind facilities in the east, it has generally been the trend that the majority of raptors observed have been below the height of the proposed turbines; the range of birds below the maximum height of the towers has been between 9 to 89 percent (Stantec 2009). Despite relatively low flight heights of raptors observed, studies have also documented high turbine collision avoidance behaviors at modern wind facilities (Whitfield and Madders 2006, Chamberlain et al. 2006). These studies found that because most raptors are diurnal, raptors may be able to visually, as well as

acoustically, detect turbines during periods of fair weather. Additionally, periods of intensified raptor movements, such as days during peak migration, are often associated with the clear weather conditions that follow certain frontal systems.

At the Stetson Wind Project during spring and fall raptor surveys, a total of 79 raptors were observed in the Project area; 46 of these birds were documented flying below maximum turbine height. Of those 46 birds, 54 percent of birds (n=25) occurred within 51 to 100 m from the turbines. Of these birds within turbine areas at heights below 119 m, 39 birds exhibited no observable reaction to turbines as they occurred over the Project ridge. Only two raptors observed during migration surveys exhibited turbine-avoidance behaviors: a turkey vulture and a sharp-shinned hawk, both on April 27. Incidental observations of raptors during the mortality survey included additional instances of raptor turbine-avoidance behaviors. Out of 47 incidental observations, seven raptors exhibited turbine-avoidance behaviors. For these seven observations, raptors made slight changes to their flight paths as they approached spinning turbines. For all nine observations of turbine-avoidance behaviors, including observations made during migration surveys and incidental observations, the turbines closest to these birds were spinning. No raptors observed came into contact with the turbines (Stantec 2009b).

While the ability of raptors to avoid turbines likely depends on a variety of factors, limited studies have attempted to quantify or estimate raptor avoidance rates, either through on-site observation or modeling. Birds presumably avoid encountering turbines by seeing the blades or detecting the motion of spinning blades, or by acoustically detecting them (Dooling 2002). Avian turbine avoidance rates have been calculated, using a model developed by Whitfield and Madders (2006) known as the “Band Model,” at several existing wind farms in the US where mainly geese and raptor species were estimated to have avoidance rates greater than 95 percent (Fernley et al. 2006). Vultures, while often common in and around wind facilities, have also collided with turbines infrequently (NRC 2007). Golden eagles were reported to have an estimated turbine avoidance rate of 99.5 percent during surveys at a US facility (Chamberlain et al. 2006).

Bald eagle observations have regularly been documented at operational facilities during raptor surveys. Results are available from surveys conducted at five operational facilities: At Buffalo Ridge, MN, 51 bald eagle observations were documented during four years of monitoring, primarily during spring migration. Direct observations of turbine avoidance behavior by raptors were made by researchers documenting movement patterns and flight behaviors of birds at the Buffalo Ridge facility in Minnesota. Birds seen flying through turbine strings often adjusted their flight when turbine blades were rotating and typically made no adjustments when turbines were not operating, supporting the theory that birds can detect blade movement by sight or sound. American kestrels were often seen at the height of the rotors and within 15 m (50 feet [’]) of turbines. However, no kestrels were found during four years of fatality searches at this site. Buteos were often observed at the height of the rotors, but were infrequently seen within 31 m (100’) of the towers. No buteo morality was reported at this facility (Osborn et al. 1998). No bald eagle fatalities were reported at any project in the US

At Foote Creek Rim, WY, three bald eagle nests are located within 10 miles of the project and post-construction observations documented 43 bald eagle observations during use surveys. In addition, at the Foote Creek Rim facility, 30 golden eagle nests were found within 10 miles of the project and over 2000 golden eagle observations recorded, yet no eagle fatalities were documented during a four-year period (Young et al. 2003).

At Erie Shores, ON, adults and juvenile eagles were seen perched within 200 m of active turbines and on a few occasions they were observed flying closer than 100 m of rotating blades. Over the course of two years, bald eagles were noted flying past active turbines within 300 m on about 170 occasions. Most of these were along the Lake Erie shore, where they routinely soared past at less than 200 m away but on five to six occasions they were observed less than 50 m from turning blades. A 2008 use study included over 3,000 observations of raptors passing within 300 m of the turbine, including 170 bald eagle observations (James 2008).

At Mars Hill, ME, post-construction monitoring results have demonstrated that migrant and resident raptors continue to use the Project area. Surveys also documented direct turbine avoidance by eagles, very similar to the behavior observed at Buffalo Ridge. Two years of post-construction monitoring were conducted in 2007 and 2008. No bald eagle fatalities have been documented in nearly three years of operation (Stantec 2009). At Lempster, NH, operation started in winter 2009. Post-construction fatality monitoring is ongoing; to date, no bald eagle fatalities have been documented.

The fact that post-construction studies have shown very few raptors being killed by turbines, and that fatalities are distributed between breeding and migration seasons, demonstrates the difficulty in determining which specific factors (flight behaviors, other seasonal behaviors, weather conditions, prey abundance and availability, raptor density, etc.) may cause raptors to collide with wind turbines at a given site. It may be more apparent why they are generally avoiding turbines. Raptor mortality from operational wind facilities in the US may be low due to the life history characteristics of raptors. In the northeast, migrating raptor species (not including owls) are diurnal animals, they are active almost entirely during daylight hours (Wheeler 2003) and their preferred prey species are generally small to medium-sized mammals, fish, and birds, which are hunted from hundreds of feet away. It requires excellent vision to hunt and capture small prey at these distances. The day-time habits and good vision of raptors may allow them to see turbines and avoid them (Chamberlain 2006) and eagles are less likely to fly during periods of high winds. This behavior has been confirmed by direct observations of raptors at some operating wind projects in the US (Chamberlain 2006, Stantec 2008, 2009).

*Nest Displacement*

Limited data exist regarding raptor displacement from wind farms in the eastern US. Data from existing facilities in the west and upper mid-west indicate that raptors continue to use the area surrounding wind developments although breeding habitat displacement was observed at a wind farm in Minnesota and at a wind farm in Ontario.

For three years after construction of a facility in Wyoming, a pair of golden eagles successfully nested within 0.8 km (0.5 mi) of the facility (NRC 2007). A Swainson's hawk nested within 0.8 km of a wind farm in Oregon (NRC 2007). Golden eagle breeding territories were monitored in 2000 and 2005 at a facility in California, and the same nesting territories were used during both years (NRC 2007). Within two miles of the Stateline facility in Oregon and Washington, raptor density remained unchanged during a two year post-construction study (NRC 2007).

After development of the Buffalo Ridge Wind Farm, raptors continued to nest in the area surrounding the Project; however, no nests were found in similar habitats within the 32 sq. km (19.9 sq. mi) facility (NRC 2007). Observed raptors, however, continued to use the Project area while foraging or flying. American kestrels were often seen flying within 15 m (49.2') of turbines (Osborn et al. 1998). However, buteos were infrequently seen within 31 m of the towers (Osborn et al. 1998). At a facility in Ontario, a pair of bald eagles nested in a wooded area within the project boundary, approximately 400 m from the turbine site. During turbine construction in winter, the pair moved to a new nest approximately 900 m from the turbine site. The pair was observed flying in the wind facility during all seasons and successfully raised two eaglets. During the next year, a pair returned to occupy the new nest but it failed early for unknown reasons. In the third year, the pair rebuilt and reoccupied the original nest. There were also two Cooper's hawk nests within 180 m of turbines and one red-tailed hawk nest within 60 m of turbine construction (James 2008).

In seven of the ten states with the highest megawatts (MW) of developed wind energy, there are over 150 bald eagle breeding pairs, and in one case, over 1,000 (Table 3-3).

**Table 3-3**. Estimated Bald Eagle Breeding Pairs in the ten states with the highest installed wind capacity

| State | Megawatts of installed wind generation capacity | # of breeding pairs of bald eagles | # of bald eagle fatalities attributed to wind turbines |
|---|---|---|---|
| Texas | 7907 | 156 | 0 |
| Iowa | 2883 | 200 | 0 |
| California | 2653 | 200 | 0 |
| Minnesota | 1803 | 1312 | 0 |
| Washington | 1479 | 848 | 0 |
| Oregon | 1363 | 470 | 0 |
| New York | 1261 | 110 | 0 |
| Colorado | 1068 | 42 | 0 |
| Kansas | 1014 | 23 | 0 |
| Illinois | 915 | 100 | 0 |
| Maine | 104 | 414 | 0 |

Sources: AWEA installed wind capacity; USFWS, April 2007; Erickson and Arnett 2008

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# Appendix 7-9
# Avian and Bat Casualty Monitoring Protocol

## 1.0 INTRODUCTION

Stantec has developed the following study protocol for post-construction monitoring to assess bird and bat casualties that may result from the amended Oakfield Wind Project (Project). The protocol is based on evolving methods associated with post-construction assessment, including the most recent efforts at Mars Hill, Stetson and Kibby, and will continue to evolve in consultation with the Maine Department of Inland Fisheries and Wildlife (MDIFW) and the U.S. Fish and Wildlife Service (USFWS).

## 2.0 BIRD AND BAT CASUALTY ASSESSMENT

### 2.1 Background

This post-construction monitoring protocol is based upon similar post-construction monitoring plans developed for other existing or proposed projects in the Northeast. The draft guidance of the Maine Wind Power Advisory Group also was considered when developing this plan. This draft guidance includes contributions by several recognized experts in the field of wind energy and wildlife interaction and other state-sponsored wind-wildlife survey protocols (e.g., the Pennsylvania Game Commission's post-construction monitoring protocols). Finally, other recent studies of bird and bat fatalities at wind power projects in the U.S. and Europe were reviewed with regard to methods and search techniques (e.g., Arnett *et al*. 2008, Arnett 2005, Kerns and Kerlinger 2004, Barrios and Rodriguez 2004, de Lucas *et al*. 2004, Krewitt and Nitchs 2003, and Osborn *et al.* 2000). The following does not necessarily represent all post-construction monitoring methods that could be employed, but does represent those required for recently constructed wind development projects in Maine. Additional surveys, if required, will be developed through consultation with MDIFW and USFWS biologists.

### 2.2 Proposed Casualty Monitoring Protocol

At a minimum, Evergreen Wind Power II, LLC (Evergreen II) proposes to fund and conduct the following wildlife casualty monitoring protocols during Year 1 operations:

1) Standardized searches during peak activity periods for birds and bats (spring migration, summer nesting and pup-rearing, late-summer swarming, and fall migration);
2) Searcher efficiency trials to estimate the percentage of carcasses found by searchers in each ground cover type surrounding the turbines; and
3) Carcass removal trials to estimate the length of time that carcasses remain in the field for possible detection.

Other survey methods will also be employed in Year 1. These methods will include documentation of casualties outside the standard search plots and monitoring of weather conditions (see Additional Survey Methods, below). A more detailed work scope for these surveys will be developed in consultation with the MDIFW and USFWS between the time that construction is initiated and the first season survey period that occurs after construction. Timing of the final work scope development in this way will allow for the incorporation of survey methods and results from publicly-available post-construction monitoring studies.

In addition, Evergreen II proposes to conduct follow-up monitoring in two subsequent years (e.g., Year 3 and Year 5). The scope and timing of the follow-up monitoring will be determined in cooperation with the MDIFW and USFWS based on the Year 1 findings, with consideration of current research priorities within the industry and the region.

#### 2.2.1 Standardized Searches

Monitoring will involve regular, systematic searches by trained technicians of the area beneath a subset of turbines. As requested by MDIFW, search preference will be given to those turbines with the largest clearings/openings, and the same locations will be maintained throughout the duration of the monitoring.

### 2.2.2 Schedule and Search Effort

Monitoring will be conducted during the first full year following completion of the Project to operational status. Subsequent survey efforts will be evaluated based upon the number of casualties documented during the initial year of survey, indications of correlations between casualties and weather, or indications of correlations between casualties and bird or bat activity.

Four distinct survey periods will occur. The timing of these periods will result in a total of 26 consecutive weeks of surveys. These survey periods are as follows.

- April 15 – May 31 for spring migration
- June 1 – July 14 for summer bird nesting and bat pup-rearing
- July 15 – August 15 for late-summer bat activity
- August 15 – October 15 for fall bird and bat migration

During each time period, a total of 25 turbines (50% of all turbines) will be searched weekly. The turbines searched will be randomly selected, though the selection will be stratified to ensure that the proportion of lighted and unlighted turbines in the searched set will be proportional to the entire Project.

### 2.3.3 Search Plot Sizes

Casualties from turbine strikes may be found at considerable distances from the base of the turbine. In some instances, casualties have been found at distances equal to or greater than the total height of the turbine and rotor, commonly in the range of 300 to 400 feet (Erickson *et al*. 2004, 2003 and 2000, Johnson *et al*. 2000a and 2000b). Survey plots to cover this range could include a substantial area of forest cover (primarily mature and mixed age forest) and in some instances, steep terrain beyond the typical 2-acre clearing needed for individual turbines. Further, because the cover and terrain in these forested settings are distinctly different from many of the published studies conducted at existing projects in the western United States, which are located in relatively level agricultural landscapes, survey methods will need to be adjusted.

As noted in the draft Maine guidelines, conducting searches at this level of intensity may simply be impractical in hilly and forested terrain. For similar reasons, Kerns *et al.* (2005) scaled down their search areas in consideration of existing site constraints. Offsetting this problem somewhat is the fact that most fatalities are being found much closer to the turbines. For example, working at the Meyersdale project in Pennsylvania, Kerns and Kerlinger (2004) reported that the majority of bird and bat fatalities were found within about 30 meters (100 feet) of the turbine bases, and Kerns *et al.* (2005) reported that greater than 80 percent of bat fatalities were found within 40 meters (131 feet) of turbines at Meyersdale, Pennsylvania and Mountaineer, West Virginia.

In light of the above, options for tailoring the monitoring methods at the Project have been considered. It is currently anticipated that the standardized searches will focus on monitoring the cleared and leveled lay-down areas around each selected turbine and applying a correction factor to account for fatalities that fall outside of the smaller search plots. The methods for calculating this correction factor will be determined through further discussions with MDIFW and USFWS and will incorporate survey results targeting this issue at turbines located in field habitat at other operating wind projects with publicly-available post-construction monitoring data. In addition, the group of turbines selected can be weighted to include those turbines located in the direct center of the lay-down areas to maximize the chances of fatalities falling within these areas where carcasses are easier to find.

### 2.3.4 Search Timing and Frequency

As noted above, systematic searches will be conducted weekly of 25 turbines (approximately 50% of all turbines) during four survey periods. These survey periods are essentially consecutive time periods ranging from four to eight weeks in length that represent different time periods of migration and breeding activity and habits of birds and bats known to occur in the area. The result will be approximately 26 weeks of consecutive casualty monitoring and a total of 702 individual turbine searches.

### 2.3.5 Standardized Searches

Plots will be searched by walking along parallel transects located at regular intervals across the turbine lay-down area. Initially, transects will be set at 4 meters (13 feet) apart. A searcher will walk at a rate of approximately 45 to 60 meters (148-197 feet) per minute along each transect and will search both sides of the transect for casualties. The search area will extend approximately 3 to 4 meters (10-13 feet) on each side of the transect. Depending upon whether casualties are found, it should take an average of 60 minutes to search each plot and then travel to the next. The need for vegetation management will be assessed throughout the season and determined in consultation with MDIFW.

All casualties will be documented on standardized field forms, photographed, and collected. If a state- or federally-listed species is found, it will be reported to MDIFW and/or USFWS within 24 hours of identification. The type of observation or condition of carcasses will be recorded, such as intact carcass, scavenged, or feather spot. From the location of the carcass, a bearing to the wind turbine will be recorded, and the distance to the turbine will be determined using a laser range finder.

Casualties found incidentally during normal on-site operations at the Project will also be recorded and collected. Operations personnel will be instructed on the proper handling and notification requirements for these occurrences.

### 2.3.6 Searcher Efficiency Trials

Searcher efficiency trials will be conducted in the same area as the searches to estimate the percentage of avian and bat casualties that are found by searchers. The trials will consist of periodic placement of carcasses at the search turbines early in the morning prior to scheduled searches (to reduce the likelihood of scavenging). Carcasses will be placed within all available ground cover types under the turbines, including the gravel access way immediately surrounding each turbine and the restored (loamed, seeded, and mulched) portions of the lay-down areas. Searchers will be unaware of the timing of these trials. Over the course of the full survey period, a target of 50 carcasses (targeting 25 birds and 25 bats) will be placed in the search plots. The number of carcasses placed for searcher efficiency trials will be modified, if necessary, based on the number of searchers used over the course of the surveys.

The carcasses used for these trials will be obtained during earlier searches at the Project or other facilities and will be marked with a small piece of string placed around a leg. If too few carcasses are available, then surrogate species of similar size as native species will be obtained. Estimates of searcher efficiency will be used to adjust for detection bias using methods similar to Jain *et al.* (2007, 2008, 2009).

### 2.3.7 Carcass Removal Trials

Two carcass removal trials will be performed during the survey, one in spring and one in fall, independently of the searcher efficiency trials. The objective will be to estimate the percentage of bird and bat fatalities that disappear from study plots due to scavengers. Estimates of carcass removal will be used to adjust the number of carcasses found, thereby correcting for this removal bias.

For each trial, a minimum of 6 but preferably 25 carcasses (species composition as noted for searcher efficiency trials) will be placed near search plots (but not in plots to avoid contamination from blowing feathers). Birds will be checked on days 1, 2, 3, 4, 5, 7, 10, and 14, or until all evidence of the carcass is absent. On day 14, carcasses, feathers, or parts will be retrieved and properly discarded. Estimates of

carcass removal will be used to adjust for carcass persistence using methods similar to Jain *et al.* (2007, 2008, 2009).

### 2.3.8 Weather Data Collection

Weather conditions will be recorded throughout the duration of the survey effort to evaluate if there are correlations with the number of casualties. Weather parameters, including wind speed and wind direction, will be recorded at the on-site met towers or at the wind turbines. Temperature at or near hub height and near the ground also will be recorded. Additional parameters include barometric pressure, relative humidity, and precipitation will be recorded.

### 2.3.9 Reporting

A report will be provided after the full year (i.e., spring and fall) of monitoring. The report will summarize the methods and results of the post-construction avian and bat assessment surveys. The report will include estimates of the total number of wind turbine-related fatalities based on five components: 1) observed number of carcasses; 2) searcher efficiency expressed as the proportion of trial carcasses found by searchers; 3) removal rates expressed as the length of time a carcass remains in the study area and is available for detection by searchers; 4) factors such as the proportion of casualties likely to land or move outside the plot (e.g., forested conditions beyond the cleared area surrounding turbines); and 5) an estimate of the number of carcasses found by observers where cause of death could not be attributed to wind energy development. The number of bird and bat fatalities on a per turbine per study period basis, and/or other possible measurement methods (i.e., per megawatt per year) will be calculated. Calculation methods are presented in Jain *et al*. (2007, 2008, 2009).

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# Appendix 7-10
# Compensatory Mitigation Plan

## 1.0 PROJECT OVERVIEW

This compensation plan is offered as wetland and habitat compensation for two amendments to the previously permitted Oakfield Wind Project. First, in this amendment application, Maine GenLead, LLC (Maine GenLead) is proposing to construct an electrical generation lead line and the associated corridor in the organized and unorganized towns of Chester, Woodville, Mattawamkeag, Molunkus Township, Macwahoc Plantation, North Yarmouth Academy Grant Township, Reed Plantation, Glenwood Plantation, T3R3 WELS, T4R3 WELS, Linneus, and Oakfield in Penobscot and Aroostook Counties, Maine. The project is expected to consist of approximately 58.5 miles of new 115-kilovolt transmission line and access roads running from Oakfield to Chester. It is designed to serve the electrical transmission needs of the amended Oakfield wind project. Approximately 35 miles of this new transmission line is co-located with existing transmission line corridor rights-of-way (ROWs).

Second, the summit portion of the Oakfield Wind Project is being amended by Evergreen Wind Power II, LLC (Evergreen II) to change the turbine types from General Electric (GE) 1.5-megawatt (MW) turbines to Vestas V-112 3.0-MW turbines; increase the total number of turbines from 34 to 50 and the installed capacity from 51 MW to 150 MW; relocate the substation and point of electrical interconnection with the electrical grid (the Maine GenLead tie line and corridor described previously), and add up to 5 permanent meteorological towers.

## 2.0 PROJECT IMPACTS

The landscape surrounding most of the project corridor and summit area has been managed for commercial forestry, in some areas heavily, for the last 50 or more years. The proposed transmission corridor is adjacent to an existing ROW for at least 60 percent of its length, and the summit project takes advantage of existing roads as much as is practical.

The wetlands along the transmission corridor are comprised of small, isolated emergent wetlands, as well as large forested wetlands, both previously disturbed by timber management activity and other naturally-occurring undisturbed features. The project crosses various state and federal waterways such as the Penobscot River, Wytipitlock Stream, and small unnamed tributaries. The majority of the wetland and stream resources are not extraordinary and are typical of the large expanses of wetlands found in north-central Maine. These resources do not support a great diversity of plant species or wildlife habitats.

The environment where this project is proposed is not an unspoiled, intact landscape. The proposed impacts associated with this project are minimal, especially considering the construction practices to reduce erosion, maintain stream and vernal pool buffers, and reduce fragmentation by co-location. None of the regulated Deer Wintering Area (DWA) habitat that would be impacted by the projects is currently functioning as a DWA, nor does it contain the canopy cover that conforms to this habitat.

The proposed corridor will impact a total of 48 vernal pools, primarily due to clearing more than 25 percent of an area 250 feet around the vernal pool depression. Six pools are naturally-created pools that meet significance criteria defined by the Maine Department of Environmental Protection (MDEP), and 12 pools either contain enough egg masses to meet the significance criteria or have other biodiversity to make them a valuable resource in the landscape regardless of their origin. The project design utilizes taller poles at Significant Vernal Pools in order to span the pools without needing to remove species capable of reaching canopy height. Maine GenLead is planning to maintain wooded buffers in this 250-foot habitat area around vernal pools by increasing the height of the poles on either side of the habitat area, cutting only those trees necessary to meet safety standards to avoid contact with the transmission line.

The Maine GenLead project will result in the following wetland and habitat impacts:

- 27.4 acres of temporary wetland, permanent wetland, and stream shore habitat impact, of which:
    - 2.1 acres are permanent wetland impact from fill associated with poles and transmission line access roads;
    - 20 acres are temporary fill in the form of mats for construction vehicles, in place for less than 18 months; and
    - 5.3 acres are upland forest clearing within 100 feet of streams.
- 133 acres of secondary wetland impacts (i.e., a result of clearing and permanent community conversion) in forested wetlands; and
- 98 acres of mapped wildlife habitat in the form of Inland Wading Bird and Waterfowl Habitat (IWWH), DWA habitat, vernal pool depressions, and habitat within 250 feet of a Significant Vernal Pool.

In addition to the impacts associated with the Maine GenLead amendment, the impacts related to the construction of the summit amendment constitute an additional 12.3 acres, comprised primarily of indirect impacts associated with the clearing of upland within 100 feet of streams:

- 0.84 acre of permanent wetland fill and temporary wetland fill;
    - 0.25 acre of permanent wetland fill; and
    - 0.59 acre of temporary wetland fill in the form of mats for construction vehicles, in place for less than 18 months.
- 4.01 acres of secondary wetland impacts (i.e., a result of clearing and permanent community conversion) in forested wetlands; and
- 7.97 acres of upland clearing within 100 feet of a stream.

The 169 acres of permanent, temporary, and indirect wetland impacts, and 98 acres of MDEP regulated habitat impacts, were calculated to require compensation[1] totaling 277 acres of upland and wetland preservation, restoration, and stream buffer and significant vernal pool buffer restoration projects. Stantec Consulting (Stantec) calculated the impact numbers for each category defined in the July 2010 U.S. Army Corps of Engineers guidance document[2] and applied Best Management Practices to reduce those numbers for a utility corridor.

Maine GenLead and Evergreen II (both affiliates of First Wind, LLC) are committed to instituting effective and appropriate erosion control measures during construction, especially surrounding the temporary construction roads, including geo-textile fabric silt fence and other materials to filter out fine sediments. All soil exposed during construction will be seeded and mulched using native species seed mixes. To avoid soil compaction from using heavy machinery, operators will grade the soil. Temporary fill, i.e., mats, will be used for a limited period of time that will not exceed 18 months. All buffers will be marked on the ground prior to beginning construction using a combination of flagging and visible signage such as a 100-foot stream buffer prohibiting the use of herbicide and any refueling or maintenance of equipment. During construction, there will be no refueling or equipment maintenance within 250 feet of a Significant Vernal Pool. Any in-stream work on delineated streams will take place between July 1 and October 15 to avoid impacting fish spawning activity.

## 3.0 COMPENSATION

To identify an appropriate compensation package for the impacts associated with these projects, the effort included calculating an in-lieu fee amount and evaluating traditional compensation options of restoration, enhancement, and preservation. A calculation of in-lieu fee approximated $9.4 million, an

[1] Corps of Engineers July 2010 Revision of the New England District Compensatory Mitigation Guidance and Central Maine Power Company Mitigation Guidance: Adjustments to standard ratios/amounts for temporary & indirect impacts activities.
[2] Ibid.

amount prohibitive to project construction, the majority of which is a result of indirect impacts associated with transmission line construction.

Maine GenLead and Evergreen II sought a compensation plan that is a) within proximity to the impact; and b) "in-kind" as defined as being representative of those impacts incurred with the ROW development/construction. The mitigation site search also focused on identifying high value resources having contiguity with other public or conservation lands. The threat of development also played a significant role in site selection. Rather than seek out several postage-size mitigation parcels, Maine GenLead selected parcels of sufficient size and quality that would maintain a functional ecosystem and provide opportunities for restoration. This search, for example, identified several smaller parcels scattered across the landscape, each of which contained some portion of the habitats and resources required for compensation. None of these parcels, however, were contiguous with the other wildlife or wetland habitats, or were adjacent to lands already protected. Additionally, the smaller parcels were in multiple ownerships, making it difficult to obtain title and thus establish mitigation of sufficient size and quality.

As a result of the site selection process, Maine GenLead identified two parcels meeting the primary criteria:

- a 979-acre parcel in Macwahoc Plantation, centrally located along the proposed transmission corridor in Aroostook County; and
- a 2,100-acre parcel approximately 8 miles from the proposed corridor in Drew's Plantation in Penobscot County.

A more detailed investigation of the parcels identified both as rich and complex compensation opportunities. Conversations with the resource agencies indicated receptiveness to protecting the parcel in Drew's Plantation and incorporating it into an existing Wildlife Management Area.

This proposed compensation area is directly adjacent on the eastern-most side to the existing Mattawamkeag River Wildlife Management Area (WMA) managed by the Maine Department of Inland Fisheries and Wildlife (MDIFW). The southeastern border is comprised of the railroad Eastern Maine Railway (subsidiary of J.D. Irving). The southwestern border is the forest land owned and managed for timber harvest by H.C. Haynes, and the northern border is the Aroostook County line with forest land in Reed Plantation.

The proposed compensation area contains 277 acres of rare and exemplary habitat along Meadow Brook. This habitat is an unpatterned fen ecosystem that receives upwelling groundwater that contains nutrients. This provides habitat for many of Maine's rare plants, and there are two known rare plant locations in the vicinity of this parcel. A more detailed survey would likely locate more occurrences.

The compensation parcel also contains 253 acres of Land Use Regulation Commission-regulated DWA that in the last 20 years (possibly as recently as 2009) has undergone cutting activity that is part of a forest management strategy. Additionally, the parcel contains 204 acres of forested wetland, portions of which are part of the DWA. These forested wetlands have been harvested.

The scrub-shrub and emergent wetlands within the parcel are prolific, occurring primarily along the U.S. Geological Survey (USGS)-mapped streams. The compensation area contains at least four potential vernal pools. These pools were identified based on National Wetlands Inventory (NWI) wetland maps and rudimentary aerial image interpretation. Based on experience in this type of ecosystem, a full parcel survey likely will reveal more vernal pools.

This compensation area is at risk of development due to its potential for future timber harvest; the DWA habitat is particularly vulnerable. An additional parcel that MDIFW is seeking to acquire on the south side of the railroad tracks was part of a plan to subdivide and sell 10 acres to another landowner nearby.

Because of the seasonal logging roads and landings, it is a realistic possibility that a similar subdivision plan is underway for this parcel as well.

This proposed 2,100 acre compensation area in Drew's Plantation provides the following compensation values:

- Adjacent to the MDIFW Mattawamkeag River WMA;
- 459 acres of wetland preservation comprised of:
    - approximately 216 acres of scrub-shrub wetland,
    - approximately 39 acres of emergent or open water wetland, and
    - approximately 204 acres of forested wetland.
- 425 acres of mapped IWWH wetland and upland buffer habitat;
- 253 acres of regulated DWA habitat;
- at least 4 potential vernal pools;
- over 15,000 linear feet of mapped USGS stream habitat in the critical habitat area for the GOM Atlantic Salmon;
- Brook trout (*Salvenius fontinalis*) habitat in the mapped perennial streams; and
- 277 acres of Rare and Exemplary habitat along Meadow Brook and two other unnamed USGS streams, an Unpatterned Fen Ecosystem.

Table 1 details the resources provided in this compensation package that meet the requirements established in the impact calculations.

## 3.1 COMPENSATION AREA VALUES

### 3.1.1 RESTORATION: WETLAND AND BUFFERS

The summit portion of the proposed project involves construction in areas with historic access roads for homesteads, camps, recreational trails, and logging activity. In some areas, these roads were re-routed to avoid impacting high-value habitats, streams, and the associated buffers. In these areas, there is opportunity to restore that portion of the habitat or wetland to its original, undisturbed condition. This process will involve removing the road bed, using the gravel material elsewhere in the project, and grading the area to match to the adjacent topography; re-vegetating using a native seed mix to avoid soil erosion; and otherwise allowing trees and shrubs to migrate and re-integrate naturally. This opportunity exists for approximately 10,000 square feet (sq. ft.) of Significant Vernal Pool buffer restoration, approximately 20,000 sq. ft. of upland stream buffer restoration, and approximately 1,800 sq. ft. of wetland restoration.

### 3.1.2 PRESERVATION: WETLANDS

The wetlands that would be protected in the compensation area total 459 acres, including approximately 216 acres of scrub-shrub wetland, 39 acres of open water and emergent wetland, and approximately 204 acres of forested wetland. Many of the forested wetlands in this area have been harvested in the last 20 years (perhaps as recently as 2009); existing roads make this parcel at risk for subdivision and future harvest. Scrub-shrub wetlands are the dominant wetland type in this compensation parcel according to National Wetlands Inventory maps. Scrub-shrub wetlands are valuable habitat for a variety of birds, mammals, reptiles, and amphibians, different than what may be found in a forested wetland. The emergent wetlands within the compensation area are primarily associated with the USGS streams and IWWH and are discussed in the following section. Some small pockets of emergent wetland occur elsewhere, typically associated with another wetland type as a percentage of a forested or scrub-shrub wetland complex.

This compensation area provides a valuable and complex mosaic of wetland and associated upland habitats across the 2,100 acres.

### 3.1.3 PRESERVATION: WILDLIFE HABITAT

Stantec's 2009 and 2010 field surveys indicate that the mapped and regulated DWAs that will be impacted along the proposed Maine GenLead transmission line corridor are not presently functioning as DWAs. There are no DWA impacts in the summit area. Past and present timber management activity removes the suitable softwood shelter stands and fragments the travel corridors. The two regulated DWAs in the compensation area have been harvested. Based on aerial photo interpretation, they do not contain conforming cover sufficient to support a wintering deer herd. Preserving these two mapped resources is a major focus of this compensation area, as is regenerating the forest canopy and prohibiting future harvest activity that is not specifically part of a DWA forest management plan.

In addition, the compensation area contains approximately three miles of perennial stream habitat, and two of the three mapped streams are direct tributaries of the Mattawamkeag River. The Mattawamkeag River is part of the critical habitat area for the GOM Atlantic Salmon and is also an existing brook trout fishery. According to the MDIFW Strategic Management Plan for brook trout,[3] the species survives best in waters below 68 degrees Fahrenheit. Protecting the canopy over tributary streams prevents the water from warming before it flows into larger streams. This practice retains the cold water river habitat required by brook trout. Brook trout are opportunistic sight feeders and are sensitive to even moderate amounts of turbidity in the water. With pressure across the state for development, it is important to preserve the wildlife habitat that is the framework for Maine outdoor sporting tourism.

Finally, this parcel includes 425 acres of mapped IWWH, of which 39 acres are open water and emergent wetland habitat. This habitat is associated with the convergence of Meadow Brook and another unnamed USGS stream and the wetland floodplain of an unnamed USGS stream before emptying into the Mattawamkeag River. These IWWHs are mapped as moderate value.

### 3.1.4 ADJACENT USES

This compensation area is adjacent to the 4,043-acre MDIFW Mattawamkeag River WMA. This WMA is part of the Mattawamkeag River Bogs and Fens Focus Area mapped by Beginning With Habitat. Surveys by the Maine Natural Areas Program indicate that this system is part of the largest unpatterned fen ecosystem currently mapped in the state, it contains two rare plant populations, and it is listed as an exemplary habitat. This WMA is managed for a variety of recreational uses, including fishing, boating, canoeing, and wildlife viewing. The MDIFW, in conjunction with The Nature Conservancy and the Maine Department of Transportation, is in the process of acquiring a 1,200-acre parcel on the south side of the railroad corridor, which will increase the WMA to 6,400 acres. It is anticipated that the compensation area would be deeded to the State of Maine to further expand the protected tract of land important to wildlife corridors and to protect the piece from potential development and timber harvest activity in this region.

## 4.0 SUMMARY

This parcel represents approximately seven times the calculated compensation acreage required for the impacts of the Maine GenLead and Evergreen II projects. The combination of diverse attributes found on this parcel---its location, continuity, resources, habitat, and threat of development—make this compensation proposal a prize for habitat and wetland restoration, land preservation, and public protection.

[3] Bonney, F.R. 2009 "Brook Trout Management Plan" Department of Inland Fisheries and Wildlife, Divisions of Fisheries and Planning. Accessed on February 2, 2011 at:
[http://www.maine.gov/ifw/fishing/species/management_plans]

**Table 1. Impact Extents, Ratios and Reductions Used to Determine Compensation Required and Provided for Evergreen and Maine GenLead Projects**

| Impacts | | | USACE Compensation Required (using standard USACE ratios and adjustment)[1] (in acres) | MDEP Compensation Required (using standard MDEP ratios and adjustment)[1] (in acres) | Standard Ratios and Reductions Used | Compensation Provided** | |
|---|---|---|---|---|---|---|---|
| Activity | | Impact Extent (in acres) | | | | | |
| **Temporary (< 18 mo) Wetland fill from Construction Access Roads** | Temporary (< 18 mo) fill in non-forested wetlands from construction access roads | 3.27 | 2.45 | not required | 15:1 to 5% | Approximately 216 acres of scrub-shrub and unconsolidated bottom wetland | |
| | Temporary (<18 mos.) fill in forested wetlands from construction access roads | 17.32 | 38.97 | not required | 15:1 to 15% | | |
| | **Total Temporary Fill Impacts** | **20.59** | **41.42** | **0.00** | | | |
| **Permanent Cover Type Conversion of Forested Wetlands to Scrub/Shrub** | | **137.4** | **61.83** | **not required** | 3:1 to 15% | 204 acres of PFO preserved | 1,800 square feet of wetland restoration |
| **Permanent Cover Type Conversion in High and Moderate Value Inland Wading Bird and Waterfowl Habitat (61% of impacts are to WWH rated moderate value)** | | **39.03** | **not required** | **64.40** | 5:1 to 33% | 425 acres of IWWH habitat | |
| **Permanent Cover Type Conversion in High and Moderate Value Deer Wintering Area Habitat (DWAs impacted are rated indeterminate value)** | | **42.89** | **not required** | **70.77** | 5:1 to 33% | 253 acres of DWA habitat protected, raised pole height in Macwahoc Co-op DWA to reduce clearing impacts | |
| **Permanent Cover Type Conversion in Vernal Pool Habitats (250 feet)[3]** | | **0.93** | **0.56** | **0.09** | 3:1 to 20%; 1:1 to 10% | 957 acres of upland habitat under silvicultural prescription. Approximately 10,000 square feet of VP habitat buffer restoration | 4 potential vernal pools identified based on NWI map interpretation. |
| **Permanent Wetland Fill** | Permanent Fill associated with Pole Locations | 0.12 | 1.95 | 1.04 | 15:1 at 100%; 8:1 at 100% | 277 acres of rare and exemplary habitat with 39 acres of emergent wetland preservation | |
| | Permanent Fill associated with Transmission Line Access Roads | 1.59 | 27.89 | 14.80 | | | |
| | Permanent Fill associated with Summit Turbine Pads and Access Roads | 0.25 | 3.75 | 2.00 | | | |
| | **Total Permanent Fill Impacts** | **1.96** | **33.59** | **17.84** | | | |
| **Stream Impacts (Clearing upland within 100')** | | **13.31** | **3.99** | **0.67** | 3:1 to 10%; 1:1 to 5% | 3 miles of wetland stream shore habitat draining into the Mattawamkeag River. | Restoration of 0.5 acres of upland stream buffer |

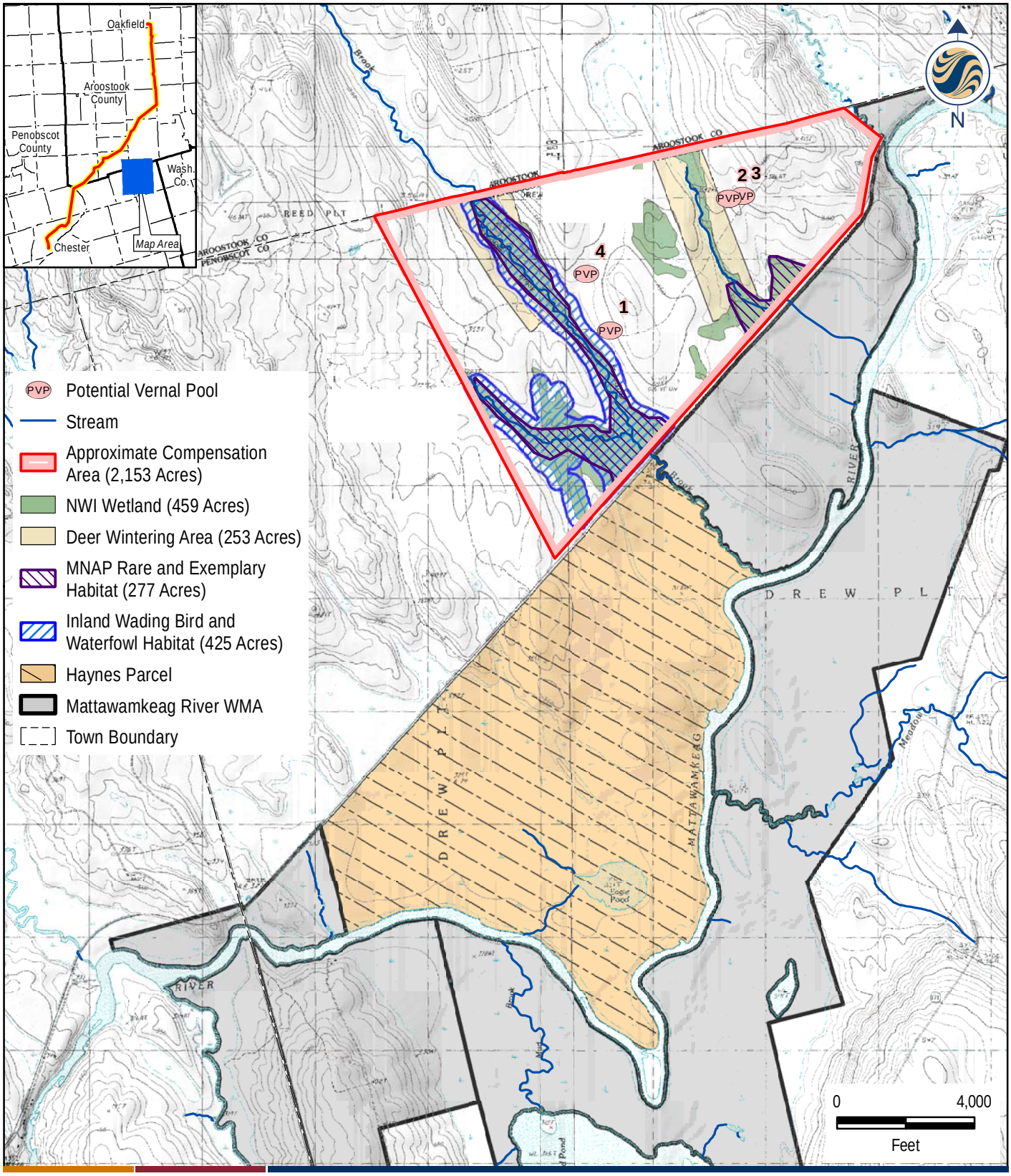
**Resources cannot be summed to find the total acres provided as compensation, there is significant resource overlap.

[1]USACE Standard Ratios: 1:1 for stream restoration, 15:1 for wetland/upland preservation, 3:1 for restoration/enhancement - also utilizing the document *CMP Mitigation Guidance: Adjustments to standard ratios/amounts for temporary & indirect impacts activities*

MDEP Standard Ratios: 1:1 for stream restoration, 8:1 for wetland/upland preservation, 1:1 for restoration/enhancement - also utilizing the document *CMP Mitigation Guidance: Adjustments to standard ratios/amounts for temporary & indirect impacts activities*

[3]Includes MDEP Significant Vernal Pools and Man-Made Vernal Pools under USACE jurisdiction which meet the MDEP Significance criteria

# Figure 1
# Transmission Line Compensation Area

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Client/Project
Oakfield 115kv Transmission Line
Oakfield, Maine

Figure No.
1

Title
Transmission Line Compensation Area
May 2011