

**Deerfield Wind Project
Post-Construction
Monitoring
Plan: Birds and Bats

(revised 11/2/2017)**

**Deerfield Wind Project Post-
Construction Monitoring
Plan: Birds and Bats**

Deerfield Wind Project, Searsburg
and Readsboro, Vermont



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DEERFIELD WIND PROJECT POST-CONSTRUCTION MONITORING PLAN: BIRDS AND BATS

Executive Summary

The Deerfield Wind Project (Project), a 15-turbine facility in Searsburg and Readsboro, Vermont, was authorized by the Green Mountain National Forest (GMNF) in 2012 and the Vermont Public Service Board (VPSB) in 2009. Once construction of the facility is complete, post-construction monitoring will be conducted during the first, third, and fifth years of full operation. The primary objectives of post-construction monitoring are to estimate annual fatality of birds and bats, to evaluate the conditions and circumstances under which fatalities take place, and to evaluate the effectiveness of operational control measures by comparing fatality at the Project to other projects in the region and investigating if and when bat fatalities are documented during the curtailment period. This post-construction monitoring plan (PCMP) outlines the methods that will be used for data collection and data analysis during the initial 3 years of monitoring, and also outlines potential conservation and adaptive management strategies to minimize impacts to birds and bats. It has been developed in coordination with both the GMNF and Vermont Agency of Natural Resources (VANR), and updated between 2012 to 2017 to incorporate recommendations from both agencies.

Bird and bat fatality searches will be conducted from 15 April to 15 October during years one, three, and five of operation at the Project. All the studies will be performed by a qualified third-party consultant, as required by Condition 15 of the Amended Certificate of Public Good (CPG). The need for, scope, and timing of additional years of monitoring will be determined in consultation with the GMNF, VANR, and US Fish and Wildlife Service (USFWS). The monitoring period will cover the peak periods of activity of birds and bats (including spring and fall migration), as well as the peak periods of fatality documented at wind projects in the region.

Operational control measures to reduce risk of collision of bats consisting of curtailment of all turbines have been mandated by the US Forest Service's (USFS) Record of Decision (ROD) for the Project. Curtailment will be implemented as per the stipulations of the Special Use Permit and operating plan for the facility, and described further in Section 4.0 of this PCMP.

From 15 April to 15 October, all 15 turbines will be searched once every 3 days (3-day search interval). If carcass persistence and searcher efficiency trials indicate that a less frequent search interval may be sufficient after Year 1 (e.g., the majority of trial carcasses are persisting for 7 or more days and searcher efficiency is reasonably high), the search interval may be modified during years 3 and 5, in consultation with the Advisory Panel. The search area at each turbine will target a 60-meter (m) radius from towers. Transects spaced 6 meters apart will be established within each search plot. Vegetation cover types within search plots and the boundaries of search plots will be mapped.

Searcher efficiency trials will be conducted during each year of monitoring, and will account for different surveyors, changes in vegetation cover throughout the study period, and each visibility class present within study areas. Trials will also be conducted to estimate the carcass persistence rate, the average length of time carcasses remain in the study area prior to removal by scavengers or other means such as heavy rain or strong winds.

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It is anticipated that the Huso fatality estimator (Huso 2010, Huso et al. 2012) will be used to estimate annual bird and bat mortality; however, the method agreed upon as the best available method at the time of reporting will be used. The estimates of fatality will account for searcher efficiency, carcass persistence, as well as the density of carcasses that may have occurred in unsearchable areas (i.e., where plots are cut off by forest edge) out to a distance of 60 meters. For each year of monitoring, an annual monitoring report will be prepared and submitted to the GMNF and VPSB.

This post-construction monitoring plan will be reviewed as new information becomes available or with substantive changes in circumstances. For example, addition of potentially-affected species to the list of threatened and endangered species, or changes in the status of or knowledge about listed species may warrant amendments to monitoring or mitigation procedures. Any such amendments would be developed in consultation with the GMNF, VANR, and USFWS.

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1.0 Introduction

The Deerfield Wind Project (Project) in Searsburg and Readsboro, Vermont was authorized by the Green Mountain National Forest (GMNF) in 2012 and the Vermont Public Service Board (VPSB) in 2009. The January 2012 Record of Decision ([ROD], USDA 2012; GMNF 2012) approved a Special Use Permit for construction of the 15-turbine Project in the Green Mountain National Forest. The Project will be operated by Deerfield Wind, LLC (Deerfield Wind), a subsidiary of Avangrid Renewables, LLC (AR). Once construction of the facility is complete, post-construction monitoring will be conducted during the first, third, and fifth years of full operation. A draft Post-Construction Monitoring Plan (PCMP) was developed in May 2012 based on guidance specified in the US Fish and Wildlife Service's (USFWS) Land-based Wind Energy Guidelines (USFWS 2012), and recommendations made by the Vermont Agency of Natural Resources (VANR) for other wind studies in the state, as well as standard methods used in the industry. This revision of the PCMP incorporates recommendations provided by the GMNF in *Recommendations for the Bird and Bat Post-Construction Monitoring Plan Deerfield Wind Project Green Mountain National Forest*, dated August 9, 2013 (GMNF 2013), and additional review and comments provided by the GMNF and VANR between 2013 and 2017. This PCMP also incorporates recommendations from the most current VANR Fish and Wildlife Department Bat-Wind Guidelines and as a requirement of an application for a Vermont State Endangered and Threatened Species Takings Permit (VANR 2016). The PCMP outlines the methods that will be used for data collection and data analysis during the initial 3 years of monitoring (first 3 monitoring sessions), and also outlines potential conservation and adaptive management strategies to minimize impacts. The study methods and analysis described here are based on methods standardly used in the region to allow comparability of results to other studies.

An Advisory Panel will be assembled for the Project, pursuant to the ROD. The Advisory Panel may include members from state and federal agencies, as well as wildlife conservation groups including GMNF, Vermont Fish and Wildlife Department, Bat Conservation International, Vermont Audubon, and USFWS.

2.0 Study Objectives

The objectives of post-construction monitoring are to:

- Estimate annual fatality of birds and bats at the Project,
- Investigate if there are project design characteristics (e.g., Federal Aviation Administration [FAA] lighting, east versus west ridge, size of rotor diameter), habitat or landscape features, weather conditions, or other factors that may increase risk of collision of birds and/or bats,
- Evaluate the effectiveness of operational control measures by comparing fatality at the Project to other projects in the region and investigating if and when bat fatalities were documented during the curtailment period, and

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- If necessary, evaluate the effectiveness of adaptive management strategies, and modify adaptive management strategies if found to be ineffective at reducing fatalities.

3.0 Study Methods

3.1 STUDY PERIOD

The VANR has recommended bird and bat fatality searches from 15 April to 15 October at other projects in Vermont, and the GMNF has indicated this timeframe would be suitable at Deerfield (GMNF 2013). As such, bird and bat fatality searches will be conducted from 15 April to 15 October during years 1, 3, and 5 of full operation at the Project. All the studies will be performed by a qualified third-party consultant, as required by Condition 15 of the Amended CPG. The need for, scope, and timing of additional years of monitoring will be determined in consultation with the GMNF, VANR, and USFWS.

The monitoring period will cover the peak periods of activity of birds and bats, as well as the peak periods of fatality documented at wind projects in the region:

- The monitoring period will cover spring and fall migration when nocturnal migrant passerines are found to be most at risk of collision, as well as the summer breeding period when some — though relatively fewer — passerine fatalities have been documented (NRC 2007). Monitoring will cover breeding and migration periods of bird species of conservation concern in the region, including Bicknell's thrush (*Catharus bicknelli*).
- The monitoring period will account for the spring and fall migration periods of migratory raptors, as well as the summer breeding period of local raptors.
- Monitoring will account for the spring dispersal, summer breeding, and late-summer and fall swarming period for bat species of conservation concern, including little brown bat (*Myotis lucifugus*), northern long-eared bat (*M. septentrionalis*), eastern small-footed bat (*M. leibii*), and tri-colored bat (*Perimyotis subflavus*). It will also cover the spring dispersal and late-summer and fall migration season of migratory tree-roosting bats including eastern red bat (*Lasiurus borealis*), silver-haired bat (*Lasionycteris noctivagans*), and hoary bat (*Lasiurus cinereus*), the species which have been found to be most at risk of collision with wind turbines in North America (Arnett and Baerwald 2013).

3.2 SEARCH FREQUENCY

During Year 1 of monitoring, from 15 April to 15 October, all 15 turbines will be searched once every 3 days (3-day search interval). It is anticipated that searches will be conducted during 4-5 days per week in an effort to sample more days during each week (e.g., 6-8 turbine searches per day during 4-5 days per week). This interval is intended to not only produce a sufficiently precise estimate of the bat fatality rate but also provide a reasonably confident indication of the occurrence of a rare fatality. If carcass

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persistence and searcher efficiency trials indicate that a less frequent search interval may be sufficient after year 1 (e.g., the majority of trial carcasses are persisting for 7 or more days and searcher efficiency is reasonably high), the search interval may be modified during years 3 and 5, in consultation with the Advisory Panel. A weekly interval is supported by results of carcass persistence trials at other projects in Vermont (e.g. Kingdom and Georgia Mountain) that have consistently shown carcass persistence to exceed 1 or even 2 weeks. Weekly search intervals are commonly used throughout the northeast, offer increased comparability among surveys, and should be appropriate for the chosen estimator based on results of bias trials from other wind projects operating in similar landscapes in the northeast.

It is anticipated that one surveyor will conduct most searches, with assistance from a second surveyor, as needed. Each surveyor will be tested during multiple searcher efficiency trials (described below) to account for any differences in searcher efficiency among surveyors. Efforts will be made to limit surveyors to 2 to 3 individuals to maximize standardization of results.

3.3 SEARCH AREA

Results from mortality monitoring studies indicate that the majority of bird and bat carcasses fall within 50% of the maximum height of turbines (Kerns and Kerlinger 2004, Arnett 2005, Fiedler et al. 2007, Young et al. 2009, Jain et al. 2007, 2009ab, Piorkowski and O'Connell 2010), with most bat fatalities falling within 30 to 40 meters of turbines (Kerns and Kerlinger 2004, Johnson et al. 2003a).

The maximum turbine height of the different turbine models at the Project will be approximately 127 meters tall. The search area at each turbine will target a 60 meter radius from towers. However, the actual area cleared of forest and the resulting ground conditions surrounding each turbine will be variable. Areas that are unsafe for surveyors (e.g., steep slopes, hazardous walking conditions) will not be searched. Further, areas that are virtually unsearchable due to dense vegetation (e.g., forest, thick and tall brush) will not be searched. Transects spaced 6 meters apart will be established within each search plot.

3.4 VEGETATION MAPPING

Because vegetation influences carcass detectability, the aerial extent of each ground cover type and respective vegetation heights within search plots will be recorded. Any significant changes in ground cover type will be noted throughout the survey period (e.g., reclamation, mowing). The aerial extent of each cover type within search plots will be mapped using a global positioning system (GPS) unit.

The visibility class for each ground cover type within plots will be classified as designated below, and the dominant visibility class will be recorded during each turbine search:

- 1 (Easy): >90% bare ground; ground cover sparse and <6" in height,
- 2 (Moderate): >25% bare ground; all ground cover <6" in height and mostly sparse,
- 3 (Difficult): <25% bare ground; <25% of ground cover >12" in height, and
- 4 (Very Difficult): little or no bare ground; >75% of ground cover >12" in height.

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The visibility class where each carcass is found will be taken into account during data analysis, as will be the variable searcher efficiency rates within different visibility classes.

The need for mowing within search plots will be assessed during each year of monitoring. If the dominant vegetation class in search plots is visibility class 3 or 4, mowing will likely be necessary to improve visibility.

Because turbine towers may not all be centered within turbine clearings and carcasses may land over unsearchable areas, the distribution of bird and bat carcasses that may have occurred within unsearchable areas out to a maximum distance of 60 meters will be estimated (as described in *Data Analysis and Fatality Estimates*).

3.5 DATA COLLECTION

Prior to initiation of fatality searches, Deerfield Wind and its contractors will obtain the appropriate state and federal approvals necessary to collect bird and bat data.

Surveyors will be trained by a post-construction monitoring manager (PCM Manager) on the standardized protocol for turbine searches. Turbine searches will begin at sunrise and will end 8 hours after sunrise in an effort to recover carcasses before removal by diurnal scavengers, and to increase the chances of recovering live birds or bats, if present. The order in which turbines are searched each day will be determined by random allocation so that individual turbines are not searched at the same time of day for each search. Searches will not be conducted during unsafe conditions (e.g., lightning, heavy rain or hail, icing on blades, turbine maintenance activities). If certain conditions prohibit searching, searches will resume the same day or the following day, as feasible.

During searches, a surveyor will walk slowly at a rate of 10–20 meters per minute looking for carcasses on either side of transects. All intact carcasses or remnants of scavenged carcasses (e.g., a cluster of feathers representing more than a molt, or a patch of skin, fur, and bone) will be documented as fatalities.

In an attempt to standardize time spent searching each turbine, the site where the carcass is found will be flagged and the fatality will be processed after the turbine search is completed. Once relocated, the surveyor will take multiple photographs of species distinguishing features and will record a GPS point (or laser range finder-distance reading and compass bearing). The following information will be recorded for each carcass found, whether found during a search or incidentally:

- Date, time, and surveyor identification,
- Turbine number,
- If the carcass was found during a search or incidentally,
- Distance (determined with a laser range finder) and compass direction of carcass from turbine tower, and/or GPS location of carcass,
- Vegetation visibility class (1, 2, 3, or 4) and ground conditions (e.g., wet, dry, snow, mud) where carcass was found,
- Carcass species identification, age (juvenile or adult), sex, and reproductive condition (to the extent possible),

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- Carcass condition (fresh or stage of decomposition, intact or scavenged, or live/injured), and
- Evidence of scavenger activity (e.g., tracks or scat).

Each carcass will be collected in an individual re-sealable plastic bag marked with a unique carcass identification number, and frozen at the Operations and Maintenance (O&M) building on-site.

Carcasses found incidentally (i.e., in non-search areas or outside of the study period), either by surveyors or other site personnel, will also be documented and collected, but will be reported separately from those found during standard searches and will not be included in calculations of fatality estimates. If a carcass is found incidentally within the study area by site personnel, the carcass will be left undisturbed so that surveyors have the opportunity to document the carcass during the next search; however, the PCM Manager will be notified as to its location. If not recovered during the next search, the PCM Manager will instruct the surveyor to collect the carcass and document it as an incidental find.

Surveyors will be trained by the PCM Manager on the proper handling of live birds and bats in the event that they are found. Any individual that handles live bats will maintain an up-to-date rabies vaccination. If allowed under the conditions of state and federal collection permits, efforts will be made to bring live, injured animals to the closest licensed wildlife rehabilitator. Surveyors should attempt immediate rehydration of live/injured animals. A list of local, licensed wildlife rehabilitators that are capable and authorized to accept regional bird and bat species will be developed prior to initiation of surveys and provided to surveyors by the PCM Manager. A qualified and licensed rehabilitator will be contacted as soon as possible to ensure that the animal has the best chance of survival. If the rehabilitator determines that successful rehabilitation is not likely, then the individual will be humanely euthanized. If the individual is federally or state-listed species, the appropriate agency will be contacted immediately before it is transported to a wildlife rehabilitator or is euthanized (if necessary). The same data collected for dead birds and bats will be collected for injured wildlife. Injured birds and bats found during searches will be included in fatality estimates, even if they are live and taken to a rehabilitator.

The GMNF, USFWS, and/or VANR will be notified within 24 hours if a large-scale fatality event takes place (i.e., more than 20 carcasses of birds or bats found across the project area in one search day, and all are assumed to have collided on the same night). The GMNF, USFWS, and/or VANR will be notified within 24 hours if a federally or state-listed species is found. Bats within the *Myotis* genus are difficult to differentiate to species and will therefore not be used for searcher efficiency or carcass persistence trials until species identification is verified and further use is approved by the agencies. All *Myotis* bats will be collected and provided to USFWS and/or VANR for inspection and verification of species identification. Identification of *Myotis* carcasses will be verified by examination by a recognized expert, DNA testing by an appropriate lab (as determined in coordination with VANR and/or USFWS), or some other mutually agreeable method.

3.6 WEATHER AND OPERATIONAL DATA COLLECTION

Weather and operations data will be collected from the Project. For fresh carcasses found during the operational control measure assessment period, weather and operations data will be obtained for the night prior to discovery from the specific turbines where the carcasses were found. On nights prior to

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scheduled searches, the surveyor will record general weather conditions including sky conditions, percent cloud cover, and cloud type from a nearby location.

Additionally, at the beginning of each turbine search, the surveyor will record daytime weather conditions, including sky conditions, precipitation, and visibility.

3.6.1 Searcher Efficiency Trials

Searcher efficiency rates are variable among studies at wind facilities in the US, and are largely dependent on ground cover conditions. Searcher efficiency rates have ranged from 25–56% for small carcasses, to as high as 100% for large carcasses (Arnett 2005, Erickson et al. 2003a, Jain et al. 2007).

Searcher efficiency trials will be conducted during each year of monitoring, and will account for different surveyors as well as each visibility class present within study areas. Trials will target the placement of 50 bird carcasses and 50 bat carcasses over the course of a monitoring year (where 1 carcass equals 1 trial), subject to carcass availability. The same individual trial carcasses will be re-used in multiple trials over the course of the study period (until they become too decomposed), and up to 20 trial carcasses may be used on a single trial day. Given that it is rare to find multiple carcasses at a single turbine (NRC 2007), “over-seeding” may occur if too many trial carcasses are placed in a small area (which may increase scavenger activity or bias searcher efficiency results). Therefore, no more than 2 trial carcasses will be placed at any time at a single turbine (Strickland et al. 2011, USFWS 2012). On trial days, carcasses will be placed at multiple turbines scheduled to be searched that day and will be placed at random distances and azimuths from turbine towers, and within different vegetation types and visibility classes.

Multiple trials will be conducted throughout the study period to account for changes in ground cover conditions. Recommended placement procedures range from distributing carcasses equally across ground cover types (USFWS 2012) to having higher sample sizes in low visibility ground cover in order to obtain more precise estimates of searcher efficiency in areas contributing to higher uncertainty in overall fatality estimates (Strickland et al. 2011). No studies to date have suggested a preferred method for stratifying trial carcass placement (Strickland et al. 2011).

Trial carcasses, in varying stages of decomposition, will be placed and discreetly marked by the PCM Manager so that trial carcasses may be distinguished from actual fatalities once found by the surveyor. If a sufficient number of trial carcasses cannot be obtained on-site, then Deerfield Wind and its contractors will attempt to obtain carcasses from outside sources. Deerfield Wind will first consult with the VANR and USFWS to identify whether either agency has a source of additional carcasses. If not, then Deerfield Wind will attempt to find a source such as academia, the Vermont Department of Health, laboratories (for surrogates), or other wind facilities, as long as precautions can be followed to avoid spreading White Nose Syndrome (WNS; in the case of bat carcasses), and to avoid poisoning scavengers (i.e., pending how surrogate carcasses are euthanized). Precautions for WNS will follow USFWS protocols.

Surveyors being tested will be unaware of trial dates and locations. The PCM Manager will leave carcasses out before sunrise at search turbines and will make every effort to leave no evidence of trial set-up (e.g., vehicle or foot prints in wet grass or mud). The PCM Manager will record the following information for each carcass placed:

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- Date, time of set-up, and surveyor being tested,
- Turbine number,
- Carcass number and species identification,
- Carcass distance and direction from tower and/or GPS location, and
- Vegetation type and visibility class where carcass was placed.

After searches are completed on trial days, the PCM Manager will determine how many trial carcasses were recovered. The presence of the trial carcass (i.e., not scavenged prior to searches) will be determined and recorded by the PCM Manager each day immediately after the completion of the survey day.

Separate searcher efficiency rates will be estimated for birds and bats. The searcher efficiency rate will be expressed as the proportion of trial carcasses found by searchers: the number of trial carcasses found divided by the total number of trial carcasses placed during trials. Estimates of fatality will account for variable searcher efficiency rates by season and by visibility class, as sample sizes allow.

3.6.2 Carcass Persistence Trials

Trials will be conducted to estimate the carcass persistence rate, or the average length of time carcasses remain in the study area prior to removal by scavengers or other means, such as heavy rain or strong winds. Average carcass persistence rates have ranged from 2 days (Fiedler et al. 2007) to 52 days (Tierney 2007, as cited in Huso 2010). Site specific factors such as habitat, year since construction, and local scavenger populations all contribute to variable carcass persistence rates.

Trials will target the placement of 50 bird carcasses and 50 bat carcasses over the course of each monitoring year (where 1 carcass equals 1 trial), subject to carcass availability. Several trial carcasses will be placed per season during the course of the survey year in order to account for seasonal changes in scavenger activity. Given that it is rare to find multiple carcasses at a single turbine (NRC 2007), carcass “over-seeding” may occur if too many trial carcasses are placed in a small area (which may increase scavenger activity). Therefore, no more than 2 trial carcasses will be placed at any time at a single turbine (Strickland et al. 2011, USFWS 2012). Carcasses in fresh condition will be used in trials and will be marked discreetly to differentiate them from actual fatalities.

If a sufficient number of trial carcasses cannot be obtained from on-site mortality, then Deerfield Wind and its contractors will attempt to obtain carcasses from outside sources. Deerfield Wind will first consult with the VANR and USFWS to identify whether either agency has a source of additional carcasses. If not, then Deerfield Wind will attempt to find a source such as academia, the Vermont Department of Health, laboratories (for surrogate quail or rats), or other wind facilities, as long as precautions can be followed to avoid spreading WNS (in the case of bat carcasses), and to avoid poisoning scavengers (i.e., pending how surrogate carcasses are euthanized). Precautions for WNS will follow USFWS protocols.

Trial carcasses will be randomly placed at multiple turbines throughout the study area and will be checked daily for 14 days. On each day a trial carcass is checked, surveyors will indicate whether the trial carcass is present (intact, or partially scavenged but readily detectable) or absent (completely removed, or with so few feathers or tissue that it would not be readily detectable). The following additional information will be recorded on standardized datasheets for each trial carcass:

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- Date, time of set-up, trial coordinator,
- Turbine number,
- Carcass number and species,
- Carcass distance and direction from tower, and/or GPS location,
- Ground cover type and vegetation height where carcass was placed, and
- Detailed notes describing any scavenging, evidence of scavenger identification, and stage of decomposition.

Separate carcass persistence rates will be estimated for birds and bats. Carcass persistence will also be calculated separately by season and by visibility class, as sample sizes allow.

3.7 DATA ANALYSIS AND FATALITY ESTIMATES

3.7.1 Fatality Estimates

Not all fatalities will be found by surveyors during turbine searches, and the need to adjust observed carcasses by multiple factors in order to estimate annual fatality has long been recognized (Huso 2010, Strickland et al. 2011, USFWS 2012). Carcasses within the search areas may be missed by searchers, carcasses may be removed by scavengers prior to the next scheduled search, or carcasses may land outside searched areas. If there were a direct relationship between observed carcasses and the number of individuals actually killed, then observed carcasses could be used as an index of fatalities (Huso 2010). However, there is no direct relationship, as factors leading to imperfect detection of carcasses (i.e., searcher efficiency, carcass persistence, searchable area) can be site-specific and annually variable (Huso 2010, Strickland et al. 2011). Therefore, trials will be performed to examine site- and season-specific searcher efficiency and carcass persistence rates. Further, ground cover types and the boundaries of search plots will be mapped to calculate the amount of searchable area below each turbine. These factors will be incorporated into an estimate of annual bird and bat fatality.

Many approaches have been developed to estimate fatality from observed carcasses (e.g., Erickson et al. 2004, Johnson et al. 2003b, Kerns and Kerlinger 2004, Shoenfeld 2004, Fiedler et al. 2007, Jain et al. 2009a, Arnett et al. 2010, Huso 2010, Tidhar et al. 2010). These approaches continue to be developed and refined as more information becomes available. It is anticipated that the Huso estimator will be used for the Deerfield fatality study; however, the method agreed upon as the best available method at the time of reporting will be used. The overall objectives of each estimator are to accurately estimate bird and bat fatality for the survey period, accounting for uncertainty due to imperfect carcass detection (i.e. searcher efficiency), areas that could not be surveyed, carcasses removed by scavengers, and search interval, and to provide a measure of precision associated with the estimates. As such, estimators will produce a single estimate for the full survey period, representing all monitored turbines. Should the Huso estimator be used as anticipated, the formula for Huso's model is available in Strickland et al. 2011:

- (C) is expressed as the product of the actual number killed.
- $\bar{t}$ is the average carcass removal time.
- P_{det} is the probability of detection given that carcass remains.

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- $\tilde{I}$ is the effective search interval.
- $\hat{\pi}$ is the probability of carcass availability and detection.
- $\hat{s}$ is estimated searcher efficiency rate expressed as the percentage of carcasses recovered during searcher efficiency trials (p in Huso model output).
- $\hat{r}$ is estimated carcass persistence rate (r in Huso model output), expressed as the proportion of carcasses estimated to remain during an average persistence interval and available for detection by the searchers.

$$\tilde{I} = -\log(0.01) * \bar{t}$$

$$\hat{s} = \min\left(1, \frac{\tilde{I}}{I}\right)$$

$$\hat{r} = \frac{\bar{t} * \left(1 - e^{-\frac{I}{\bar{t}}}\right)}{I}$$

$$\hat{\pi} = P_{det} * \hat{s} * \hat{r}$$

When the size of search plots is limited, it is likely only a fraction of carcasses occurring at a turbine (i) will occur within the searchable area (Huso 2010). Therefore, π_i is the product of the proportion of fatalities at turbine i that is within the searchable area of a plot and probability of including (i) in the sample.

Because turbine towers may not be centered within turbine clearings, and carcasses may land over unsearched areas, the empirical distribution of bird and bat carcass fall distances will be determined in order to apply a density-weighted proportion area searched (DWP) correction in the model. Area corrections will be based on methods proposed by Jain et al. 2009c (modified from Fiedler et al. 2007). The proportion of the total birds and bats found during searches will be determined per 10 m concentric distance increments radiating out to a distance of 60 m (the maximum search radius) from tower bases. The proportion of the area that was searchable (i.e., not cut off by forest edge) within each of these distance bands will be determined. The percent area searched per distance band will be multiplied by the proportion of bird and bat carcasses found within each distance band to find a DWP value per distance band. The DWP value for each band will be summed to find a DWP value for each turbine, for birds and bats separately. Turbine-specific DWP values will be input into the model for each bird and bat carcass found. This DWP analysis provides a per-turbine adjustment for the total number of bird and bat carcasses that would have been found within a 60-m radius of the turbine, had that entire area been available to be searched. It should be noted that a small density of carcasses found does not allow for a robust estimate of DWP; for example, if one bat carcasses is found in an outer ring of a search plot, and a small proportion of this ring was searchable, this one bat will inflate the estimate of the number of

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carcasses that may have occurred within this ring, when the actual distribution of bats indicates that the number of bat carcasses actually drops off in the outer portions of plots.

In order for the Huso estimator to calculate estimates of fatality for birds and bats separately, a sample size of at least 10 bird and 10 bat carcasses for both the searcher efficiency and carcass persistence trials is required. Further, there must be a sample size of at least 10 bird or bat carcasses per covariate (e.g., season, carcass size, ground cover type) for other covariates to be incorporated into the model (e.g., to estimate fatality per season, per carcass size, per visibility class).

The results of searcher efficiency trials will be input into the model as 1 (if the trial carcass was found) and 0 (if trial carcass was not found). These values are distributed as binary random variables within the model, with 'Found' indicated by the highest numeric value. A generalized linear model of the binary response is fit to the data, with a modeled response of $\log_e$ (odds of observing a carcass = $\log_e(p/1-p)$).

The results of carcass persistence trials will be input into the model, based on the following trial outcomes:

- Carcass gone at first check on 'Day 1' of trial, left censoring = 2,
- Carcass still present (visible) on last day of trial, right censoring = 0, and
- Carcass was removed between checks, interval censoring = 3.

Carcass persistence times are modeled with a log-linear parametric accelerated failure time model and are assumed to follow a probability distribution. When persistence time is not known or is censored, the model is appropriately modified.

Each time the model is run, one of the following distributions of carcass persistence must be selected by the user for the model: Exponential, Loglogistic, Lognormal, or Weibull. Huso recommends running trials of the dataset with each distribution to compare values of AIC (Akaike information criterion), the measure of the relative goodness of fit of the model, where k is the number of parameters in the statistical model, and L is the maximized value of the likelihood function for the estimated model.

$$AIC = 2k - \ln(L)$$

The preferred distribution for the dataset is the one with the minimum AIC value.

Thompson (1992) provides a formula for the calculations of variance when the variables of the model (i.e., carcass detectability and persistence) are known. However, because detection bias, persistence bias, and proportion of carcasses within search areas are estimated, Huso uses a bootstrapped estimate of variance based on methods proposed by Erickson et al. 2004, where the fatality adjustment (π) and total fatality (m) are calculated for each bootstrapped sample. This analysis will use 5,000 bootstrap resample iterations, as recommended by Huso et al. 2012. The alpha value will be defined as 0.05; therefore, all confidence intervals will be calculated at 95%.

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3.7.2 Additional Data Analysis

The following data summaries and analyses will be conducted based on the temporal and spatial distribution of bird and bat fatalities found at the Project:

- The numbers of birds and bats, and the number of species and species groups found (injured birds and bats found during searches are to be included in fatality estimates, even if they are live and taken to a rehabilitator),
- Seasonal timing of fatalities,
- Distribution of fatalities compared to proportion of time turbines are curtailed,
- Nighttime weather conditions for nights prior to when fresh fatalities were found,
- The range of distances that birds and bats were found from the towers, and the average distances birds and bats were found from towers,
- The distances and azimuths of carcasses from turbine bases, plotted on a scatterplot diagram within 10 m concentric distance increments,
- The dispersion of bird and bat fatalities among individual turbines,
- The dispersion of fatalities at turbines in different landscape settings (saddle, crest, or side slope),
- The dispersion of fatalities at FAA lit versus unlit turbines,
- The dispersion of fatalities at turbines on east versus west ridges, and
- The dispersion of fatalities at turbines with different sized rotor areas.

3.7.3 Reporting

For each year of monitoring, an annual monitoring report will be prepared and submitted to the GMNF and VPSB by February 28th of the following year. The report will describe study methodologies and results, including the number, species and locations of all carcasses found, the methods used for data analysis, as well as any correlations between bird and/or bat fatality and project design characteristics, habitat or landscape features, weather conditions, or other factors.

4.0 Adaptive Management Strategy

4.1 OPERATIONAL CONTROL MEASURES

Curtailment is an adaptive management strategy stipulated in the Deerfield Wind Project decision document (Record of Decision, or ROD) to minimize bird and bat mortality. The details of curtailment

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will be implemented as per the stipulations of the Special Use Permit for operating the facility. Those specifics are described in the ROD, and may actually differ from what was stated in the ROD pending any threatened or endangered listing from the U.S. Fish and Wildlife Service (see 4.1.1 below).

Curtailment will be achieved by switching all the turbines into a “pause mode” or similar in order to prevent normal turbine operations until such a time where the target wind speed is exceeded. Under curtailment, turbines in this “pause mode” are revolving at a rate less than or equal to 1 revolution per minute (rpm).

Pending the results of the assessment, operational control measures to be implemented for the life of the Project may be modified if deemed necessary by Deerfield Wind, GMNF, VANR, and USFWS.

4.1.1 Operational Control Measures Related to the Northern Long-eared Bat

On April 2, 2015, the USFWS listed the northern long-eared bat (*Myotis septentrionalis*) as a threatened species under the Endangered Species Act (ESA). On January 14, 2016, USFWS issued a final ESA section 4(d) rule for the northern long-eared bat. The 4(d) rule exempts incidental take of the northern long-eared bat from the ESA section 9 take prohibition, unless incidental take occurs under certain circumstances, such as activities taking place within hibernacula or involving tree clearing within certain distances of special life cycle features (hibernacula and maternity roosts) and during certain time periods (i.e. pup season) (81 Fed. Reg. 1900). As operation of the Project does not fall under these circumstances, incidental take of the northern long eared bat is not prohibited by the ESA and therefore, the operational control measures described in Section 4.1 and in the ROD exceed any measures necessary for the northern long eared bat.

As adaptive management of operations is fundamental to the findings in both the ROD and the Project's Certificate of Public Good (CPG), the Project will implement appropriate measures to respond to listing of the northern long-eared bat, as well as other future bat listings. Any change to the operational control measures described in the ROD will be done in consultation with the GMNF and VANR.

4.2 CONSERVATION MEASURES

As specified in the VPSB's CPG, if the project demonstrates an ‘undue adverse impact’, Deerfield Wind must develop a specific adaptive management plan to reduce fatality rates of the affected bird or bat species. This plan would be submitted to and reviewed by the Advisory Panel that would be assembled for the Project, pursuant to the ROD.

If the following bird and bat species of conservation concern — little brown bat, northern long-eared bat, eastern small-footed bat, tri-colored bat, or Bicknell's thrush — become listed under the federal Endangered Species Act, Deerfield Wind will consult with the GMNF to discuss if there are additional measures, beyond the Project's operational control measures already being implemented, required to reduce impacts to these species.

Deerfield Wind recognizes that additional monitoring may be required in the event that bird or bat fatality observed at the Project is outside of the range of other similar projects in the region or the unexpected

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discovery of a listed species occurs. The scope of, timing, and specific objectives of additional monitoring would be determined in consultation with the Advisory Panel.

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