Draft

Avian and Bat Survey Protocols
for Large Wind Energy Conversion Systems in Minnesota

Minnesota Department of Natural Resources
Division of Ecological and Water Resources
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Introduction

The State of Minnesota has experienced substantial new development of wind energy projects as interest in renewable sources of energy production increases. Wind energy conversion systems provide electricity using an energy source lacking some of the environmental challenges of other sources, with less concern regarding air and water pollution and release of greenhouse gases. Wind energy does, however, have the potential to affect avian and bat species with direct impacts such as collision and barotrauma (tissue damage due to pressure changes), or indirect impacts such as habitat loss, avoidance of habitat, and other behavioral changes. Careful siting of wind projects is considered one of the most useful tools for avoiding and minimizing impacts to birds and bats. Understanding species behavior in relation to the project area helps facilitate proper infrastructure siting, which can be used as a mechanism to avoid and minimize avian and bat impacts. Understanding actual project impacts by assessing fatalities occurring during operation can also inform wind farm operation and help better plan for future project siting.

Using existing data in Minnesota, regarding effects to avian and bat species, has become increasingly difficult due to the expansion of projects across ecological provinces and the use of taller turbines with greater rotor diameters. Although data from other states provides direction for project planning it is often unpublished, results from various survey methods, and describes effects from habitats with different species use than Minnesota. Data specific to projects in Minnesota will assist with understanding possible avian and bat impacts as expanding renewable energy development increases the possibility for cumulative impacts to species populations. Pre- and post-construction surveys are beginning to be conducted in Minnesota. However, methods for surveys are determined by individual project proposers or state and federal agencies on a project-by-project basis. The following standardized pre- and post-construction survey methods are intended to provide for more efficient agency coordination and project development. They also assist in providing a more robust record for decision makers, reduce uncertainty in project development for the wind industry, and provide for more comparable and broad application of results.

The Public Utilities Commission (PUC) and Office of Energy Security (OES) conduct environmental review and site permitting of large wind energy conversion systems for the State of Minnesota. The Minnesota Department of Natural Resources (DNR) is responsible for the regulation of wildlife of the state (Minnesota Statutes 84.027 Subdivision 2), regulates utility crossings, work in public waters, and threatened and endangered species takings, and provides technical input to the PUC and OES regarding possible natural resource impacts of commercial wind energy facility projects. The United States Fish and Wildlife Service (USFWS) provides input regarding federal regulations and recommendations to the PUC and OES. Counties also issue permits for smaller projects (< 5 MW and delegated 5-25 MW). The Agencies (DNR, OES, PUC, USFWS) each perform their regulatory responsibilities and provide coordination and technical assistance among organizations as needed.
The following sections include DNR recommendations for protocols to be used for pre-construction assessment of wind farm siting and project planning and for post-construction assessment of avian and bat fatalities. Pre-construction protocols include methods for assessing avian flight path characteristics, bat presence using acoustic monitoring, and avian use of grassland and wetland habitats. Post-construction protocols are included to assess estimated fatalities to birds and bats at operating commercial wind farms. Coordination with the Agencies is strongly encouraged in the early planning stages of project development to ensure the appropriate surveys, methods, and locations are studied. Agencies can identify potential habitat that should be surveyed, and will identify which protocol(s) should be used in consultation with the project proponent.

It is important to note that a description of commonly used pre-construction point count avian survey methods is not included in the following sections. The intent of DNR recommended survey protocols is to encourage the use of limited resources and time in a way that obtains the most useful data for avoiding avian and bat impacts. The DNR recommends that surveys focus on potential habitat for state-listed (threatened, endangered, or special concern), federally listed species and Species of Greatest Conservation Need (SGCN) rather than on habitats and species often targeted with general point counts. General point counts along roads and disturbed areas (i.e. farm fields) are usually not a valid method, when used alone, for determining the presence of listed species. Point counts along roads typically provide a list of generalist avian species that use fragmented habitat.

Protocol recommendations fit into project planning and operation in a similar manner to United States Fish and Wildlife Service (USFWS) Land-Based Wind Energy Guidelines Tiers 3 and 4. These tiers are recommended for commercial wind projects to complete on-site field assessments (Tier 3) and post-construction surveys (Tier 4). The decision about how to proceed with Tiers 3 and 4, as outlined by the USFWS Land-Based Wind Energy Guidelines, is based on estimated risk level. A project proposer should coordinate with the Agencies to determine an estimated risk level based on desk-top review of potential wind energy project locations and initial site visits to assess natural resource features (see DNR Resources for Project Assessment). Desk-top review and initial site visit steps correspond with Tier 1 and Tier 2 of the USFWS Land-Based Wind Energy Guidelines. Then, as appropriate for the risk level identified, protocols included in the following sections should be used for Tier 3 and Tier 4 analyses. The risk level can also be adjusted as appropriate based on survey results and avoidance of high risk areas during preliminary infrastructure layout planning.

Assessment of specific rare species or other wildlife that may be at risk by development of a commercial wind project should also be completed for each project. If records or surveys indicate the presence of state-listed (threatened, endangered, or special concern) or federally listed species, or if they are present at a project site, project developers should coordinate with the Natural Heritage Review Coordinator (see DNR Resources for Project Assessment) regarding species-specific survey methods. These methods may be in addition to the protocols outlined in this document.
Avian and Bat Survey Protocols for Large Wind Energy Conversion Systems in Minnesota is intended to be updated periodically. This approach reflects the dynamic nature of the understanding of interactions between wildlife and commercial wind farms and allows for inclusion of new information as this field of study develops. Also, if wind energy continues to develop in increasingly diverse habitats in Minnesota, such as forested habitats, additional sections may be added to include suitable survey protocols.

DNR Resources for Project Assessment

- Minnesota State Wildlife Action Plan: Tomorrow’s Habitat for the Wild and Rare
  http://www.dnr.state.mn.us/cwcs/index.html

- DNR Natural Heritage Information System
  http://www.dnr.state.mn.us/eco/nhnrp/nhis.html

- DNR Environmental Review – Regional Program and Contacts
  http://www.dnr.state.mn.us/eco/ereview/erp_regioncontacts.html
Section 1
Risk Determination

The initial wind company risk analysis is the single most important step used to establish a project boundary in a manner that minimizes the risk to wildlife. Properly sited project boundaries result in the Minnesota Department of Natural Resources (DNR) recommending a lower risk level that corresponds to a reduction in wildlife surveys for the project. The DNR preliminary review of proposed wind projects involves an assessment of the potential risks to wildlife by siting turbines and other infrastructure in the prior wind company established project area. The DNR recognizes that assigning risk levels in the preliminary review phase is challenging due to limited pre-construction data (acoustics, flyways, listed species, etc.), unknown migratory paths of neo-tropical migrants and tree bats, sparse information on species behavior/response to turbines, and other undetermined factors. However, assigning a risk level is used to facilitate the discussion on what wildlife surveys should be conducted in order to better inform the decision making process. The DNR may recommend bat acoustics, avian flyway, listed species, avian wetland, or other surveys to further understand the species and their behaviors within a project area. This information can then be used to refine the risk level of the project. The refined risk level is also related to the level (high or moderate) of fatality monitoring that will be recommended.

In some instances a portion of the project site will be considered high risk due to high value habitat being concentrated in one area. Avoiding the placement of infrastructure in high risk portions of the project area may result in lowering the risk level which effectively reduces the survey effort. The remainder of the project area may fall under moderate or low risk categories. In some situations the risk level may be adjusted lower if the project boundary or turbine layout is modified to avoid high risk areas. In other instances the risk level could be adjusted higher if new information is available concerning listed species or survey data indicates a higher level is justified.

During preliminary project development wind developers should refine project boundaries to avoid high value resources. The further avoidance of high value resources is a mechanism to potentially downgrade the risk level of the project area. Typically with a reduced risk level you have a reduced amount of recommended wildlife surveys. As the initial turbine layout is developed it too can be refined to avoid placement of infrastructure in or near high value resources.

Of considerable importance in assigning risk level is the experience of DNR staff that has reviewed and compared projects within the same general landscape. The comparison of projects using Geographic Information System layers, field reconnaissance, and input from field staff allows the DNR to have the unique perspective of understanding the risk level of a project area. Without this background it is difficult to assign risk levels to a wind project site.
Wind project areas are high risk when significant wildlife habitat is within or adjacent to the site that could congregate birds or bats, listed or SGCN species are known to occur in the area, hibernacula are present, migratory or local flyways exist, or other factors are known or suspected. Significant wildlife habitat can be large blocks of grassland or forest, wetland, stream corridors, prairie, or other high value habitats that may increase avian or bat use of the area. The DNR Wind Guidance for Large Wind Energy Conversion Systems outlines many of the high value resources that should be identified during the preliminary development of a project.

Risk assignment can be based on many factors or just 1 high risk factor. For example, if you have a colonial nesting site in a project area that 1 resource could provide the basis for a high risk site. In other project areas it may be a combination of wetlands, streams, state or federal lands, and other wildlife habitat present within or immediately adjacent to the project area.

Some companies may conduct wildlife surveys on projects the DNR believes are low risk sites due to standard company practice or based on USFWS recommendations. In these situations the DNR supports the surveys provided the methods remain valid and the data interpretation is consistent with the quality of the data. The methods should be coordinated with all of the agencies prior to conducting any field work to ensure the methods and manner of interpretation are acceptable to all parties.

Following is a general list of potential factors that can contribute to the risk determination:

**Risk Determination Factors**

**High Risk**

High value habitats, as identified using categories in the DNR Wind Guidance document, present with potential avian or bat use.

*Increased number of parcels and acreage of high value habitat increases the risk level due to the probability of increased species diversity and population abundance in the area. The DNR field assessment differentiates quality of habitat present. The position of the high value habitats across the landscape influences risk determination for the entire project or a portion of it.*

*The type, acreage, number, and locations of wetlands have a considerable influence on the risk assigned to a project. Typically, as the number and diversity of wetlands increases the risk level increases.*

Listed or SGCN avian or bat species known to be present.

*Species behavior or location in relation to turbines increases risk.*

*Pre-construction data can influence risk level up or down.*
Raptor nests present (emphasis on bald eagles or red-shouldered hawks).

*Raptor nests add to the risk due to the constant flights of adults in and out of the area over long periods for nest building, courtship, and feeding the young.

*Recently fledged birds are still developing their flight muscles, lack maneuverability, and have no prior experience avoiding turbine blades.

*Bald eagle nest presence in or near the proposed wind project increases risk and triggers additional coordination with the USFWS.

Colonial nesting species known to occur within or adjacent to the site.

*Colonial nesting concentrates species into a small area that can have established flight paths to foraging areas. The concentration of inexperienced birds fledging and staging around the sites increases the risk of fatalities.

Hibernacula present in or within 5 miles of project boundary.

*Use data/surveys to establish risk based on species and relative populations.

*The closer to the project area the greater the risk.

*Potential/verified foraging habitat and travel corridors within the project area.

Potential bat roost trees/structures in or within 5 miles of project boundary.

*Suitable roost trees can potentially increase the use of the project area and likelihood of bat turbine interactions.

*Known or surveyed structures occupied by bats (old barns, mine workings, bridges (used for summer roost or maternity sites).

Existing data indicates high use by birds or bats (NHIS, Wildlife Area Manager, other wind project data).

*High use by birds or bats increases fatality risk.

Large blocks of habitat for birds will be fragmented by access roads, turbines, or transmission lines.

*Fragmentation of block habitat reduces forest or grassland interior nesting habitat by species that avoid nesting near habitat edges. Some species, that are intolerant to fragmentation, will no longer nest in habitat patches that are fragmented into small patch sizes.

Pre-construction bat acoustic data indicates high bat passes or migratory bats present.

*Bat specialists major concern is migratory tree bats and verification of use in the project area may result in a higher risk level.
Pre-construction data indicates avian concentration areas.

*Avian concentration areas raise the risk level due to potential fatalities and habitat avoidance.

Pre-construction data indicates avian flight paths exist.

*Avian risk increases when defined flight paths intersect with turbine locations.

Project is high risk when compared to other projects in the same landscape setting.

*DNR staff will have insight on the risk within a particular region when comparing one project area to other projects. The field based experience and review of data from other projects influences the DNR risk level.

Cumulative impacts to the same high value habitat or species locations.

*When projects are located in the same area the combined wind infrastructure can increase the magnitude of potential impacts in the local or regional area. This effectively increases the risk of cumulative fatalities, habitat avoidance, fragmentation, and other impacts.

Other factors as determined on a project by project basis.

**Moderate Risk**

High value habitats present, but in fewer locations and lower acres than a high risk site.

High value habitats are dispersed or outside of the project boundary.

Reduced amount of potential bat habitat (roost trees, stream corridors, wetlands).

No listed avian or bat species known to be present or listed species present are at a lower risk of fatality.

No significant bat hibernacula within 5 miles (significance is based on species and abundance).

No known avian concentration areas.

Reduced number of SGCN present or they are at a lower risk of fatality.

Pre-construction data suggests the site is of moderate risk.

Inconclusive pre-construction data for birds or bats.

No pre-construction data available.

Unknown migratory paths.

Project is moderate risk when compared to other projects in the same landscape setting.
Following are high, moderate, and low risk maps that will clarify the thought process in determining risk levels for a project. Note that high risk sites have a greater number of parcels containing habitat (Wildlife Management Areas, Waterfowl Production Areas, Reinvest In Minnesota, Public Waters, etc.) than moderate risk sites. Low risk sites have a lack of significant habitat within or adjacent to the project area. Pre-construction data, when available, also factors into the risk level along with the potential for impacts to SGCN or listed species. Also note that by adjusting the project area away from the high value habitats that the risk level may be reduced.
Section 2

Bat & Avian Fatality Monitoring  
at Large Wind Energy Conversion Systems In Minnesota

Introduction

Fatalities to birds and bats from collisions, or barotrauma, with wind turbines is well documented in the literature. Fatality monitoring is needed in Minnesota in order to improve our understanding of the impacts. Fatality data can be used to improve project micro-siting, future wind project locations, and determine the need for fatality minimization measures. Using standardized fatality protocols allows for the scientific collection of data that can be used to determine reliable fatality estimates that can be compared and pooled with data from multiple wind energy sites within Minnesota. Due to the substantial influx of wind energy conversion systems in Minnesota, the DNR is concerned about potential avian and bat fatalities that occur on a regional and statewide basis. These methods have been designed for use on individual projects or for a statewide perspective concerning fatalities. The same data collection methods and analysis has to be used in order to combine data or to compare data collected from different sites.

Minnesota is home to seven bat species that may be found throughout the state in varying habitat types. There have been records of 428 bird species found within the state with 44 being year round residents and 384 species being migratory. Twenty-eight of these species are listed species (species of concern, threatened, or endangered). Fatalities occur to birds and bats on a regional and statewide basis due to the existing commercial turbines. When fatalities are combined from all of the operational commercial turbines the impacts may be significant to some species. Based on data from July, 2012 the Department of Commerce has indicated that 1,997 known commercial turbines are in operation within Minnesota (PUC web site) with a name plate capacity of 2,739 MW. A hypothetical example of potential fatalities can be expressed as 5 bird and bat deaths per turbine per year \( \times \) 2,000 operational turbines = 10,000 fatalities per year. With further development to 2,500 operational turbines the number of fatalities expands to 12,500 fatalities per year. These numbers are used solely as an example to crudely illustrate how fatalities may be significant on a cumulative basis. The lack of fatality data available prevents estimating fatalities from operational turbines in the state of Minnesota and assessing species impacts from individual projects and cumulatively.

Fatality data was collected in Minnesota on Buffalo Ridge in the 1990’s. Project developers often reference the results of the Buffalo Ridge studies and assume that other locations in Minnesota will have similar fatalities. However, fatality data collected across the country has shown that bird and bat fatalities can vary dramatically from turbine to turbine within the same wind farm and even more from wind farm to wind farm. The variations in fatalities are likely due to differences in topography, habitat, migratory corridors, species present, population levels, weather, turbine design, and prey abundance. The Buffalo Ridge site contains habitat that is substantially different than other locations in Minnesota and radar studies have shown a lower number of avian migrants in the Buffalo Ridge area than in other parts of southern Minnesota.
In addition, turbine design (height, rotor diameter, and cut in/out speeds) and fatality protocol have evolved with the potential to influence actual fatality and fatality estimates. As such, fatality studies need to be conducted in each of the ecological provinces (i.e., prairie/agricultural, deciduous, coniferous) of Minnesota in order to understand impacts of modern wind energy facilities in a variety of habitats and to establish valid avian and bat fatality estimates. In addition, understanding which species are being killed is important for understanding how to avoid and minimize fatalities.

**Fatality Protocol**

Fatality protocols have been developed based on the risk level of the project area. High risk sites contain habitat that would congregate birds or bats, verified presence of listed species or SGCN, acoustic data indicates high bat passes or migratory tree bat presence, avian flight paths, or migratory corridors. Moderate or low risk sites contain features similar to high risk, but are concentrated in a portion of the project area or of lower quality. Of considerable importance in assigning risk level is the experience of DNR staff that has reviewed dozens of projects. DNR experience allows for the comparison of risk level among wind projects within a particular landscape.

Minnesota endangered species law (*Minnesota Statutes* section 84.0895) and associated rules (*Minnesota Rules* part 6212.1800 to 6212.2300 and 6134) prohibit the taking of endangered or threatened species without a permit. The MN DNR may recommend specific fatality protocol for project sites with verified state-listed species present within, immediately adjacent to, or that migrate through the project area. The methods may be substantially different than the protocols established within this document and would be determined on a project by project basis.

**Fatality Monitoring For High Risk Sites**

Wind project areas are high risk when significant wildlife habitat is within or adjacent to the site, listed species are known to occur in the area, hibernacula are present, or migratory or local flyways exist. Significant wildlife habitat can be large blocks of grassland or forest, wetland, stream corridors, prairie, or other high value habitats that may increase avian or bat use of the area. Pre-construction survey data, if available, will also be considered when determining the risk level. The general risk level of a project area will be determined during the preliminary review of the project. In some instances a portion of the project site will be considered high risk due to high value habitat being concentrated in one area. Avoiding the placement of turbines in high risk portions of the project area may result in lowering the risk level which effectively reduces the survey effort. The remainder of the project area may fall under moderate or low risk categories. In some situations the risk level may be adjusted if the project boundary or turbine layout is modified to avoid high risk areas.
Please note that assigning risk level to projects is challenging due to limited pre-construction data, unknown migratory paths of birds and tree bats, sparse information on species behavior/response to turbines, and other undetermined factors. Assigning a risk level is used to facilitate a greater expenditure of effort on projects with known higher risk features and a reduced effort for lower risk sites. The Agencies may recommend additional monitoring if unusually high fatalities are occurring or if state-listed species are killed.

Duration and Frequency of Monitoring

All fatality monitoring for high risk sites should be conducted 4 days per week for the period between March 15 and November 15 for 2 or more complete years following construction, unless other credible fatality information is available and reduced monitoring can be justified. The United States Fish & Wildlife Service should be consulted if bald eagles are known to use the project area as the survey period would need to be adjusted to include year round searches or additional monitoring from November 15 to March 15 using modified methods. Daily searches are recommended by numerous states including Pennsylvania (Capouillez et. al. 2007), New York, and Ohio. However, reliable fatality estimates can be achieved using 4 search days per week while effectively reducing survey costs.

Four day per week searches are recommended in order to increase the positive identification of species killed and improve the fatality estimates by decreasing potential bias associated with fewer search days. Increasing the number of search days increases the number of carcasses collected and positively identified prior to scavenger removal. Increasing the positive species identification is essential in understanding the impacts to listed species, species in greatest conservation need, and other avian or bat species killed in high numbers. Without positively identifying which species are being killed you cannot assess impacts to listed or rare species, migratory species, understand cumulative impacts, determine the need for curtailment, or understand habitat to turbine relationships. Without positively identifying the species killed you cannot start to address mechanisms to avoid and minimize impacts because the species behavior and habitat use is crucial to this endeavor. Low searcher detection and high carcass removal can lead to high uncertainty and high variation of estimated mortality (Erickson 2008). In order to reduce the effect of high carcass removal you need to increase the number of search days per week. For additional insight on search days, searcher efficiency, scavenger removal, and bias associated with fatality searches see Arnett (2008), Smallwood (2007), and Strickland (2011).

In order to handle and possess carcasses you will need a DNR Special Permit (Scientific Research) from Wildlife Research (612-713-5438) and a U.S. Fish & Wildlife Service Migratory Bird Permit (612-713-5438).

Number of Turbines to Monitor

Turbines monitored will follow the guidelines below as per “Standard Fatality Transect Survey”, and will include validation procedures to correct for bias. Validation procedures include trials for scavenger removal and searcher efficiency. Monitored turbines should be identified in consultation with the Agencies and focus on the higher risk turbines. Higher risk turbines are located in close proximity to high value habitats as defined by the DNR Wind Guidance for
Large Wind Energy Conversion Systems. High risk locations may include proposed turbines in proximity to habitat supporting listed species, large blocks of grassland or forest, stream corridors, large lakes or wetland complexes, and known avian or bat concentration areas. Twenty percent of the turbines should be searched (minimum of 10 and maximum of 25). A different set of turbines should be monitored in the second year. Coordination with the Agencies should occur to determine which turbines are selected for searches.

Fatality Monitoring Procedures

Scavenger removal and searcher efficiency trials will be performed, and the duration, frequency and number of turbines to monitor are the same. The search area should be cleared of all carcasses prior to March 15 and the initiation of data collection. The carcasses should be identified and reported separately from the data collected from March 15-November 15 and should not be used in the fatality estimates.

At each turbine to be monitored, a rectangular plot that is 80 meters from the base of the turbine in each cardinal direction will be established (160 meters per rectangular side based on the center of the turbine). Although evidence suggests that > 80% of the bat fatalities fall within ½ the maximum distance of turbine height to ground (Erickson 2003a,b) search areas vary and often do not allow surveys to consistently extend to this distance. Strickland (2011) recommends search plots for birds to be approximately the radius of the maximum distance from the ground to the highest point on the rotor swept area. Therefore, the searchable area underneath turbines will be delineated and mapped, and estimates of fatality will be produced. Maps should be constructed illustrating all turbine locations, a designated numbering system for turbines, boundaries of survey areas, and searchable areas (broken down into visibility classes and transect numbering for standard transect surveys).

1) Transects are established that are 6 meters apart that are marked every ten meters. Surveyors search for carcasses within 3 meters of each side of each transect.
2) Searches should start on transects running past the base of the turbine and working outward. Turbines with no vegetation or sparse vegetation should be searched for a minimum of 1 person hour (1 person-1 hour, 2 person ½ hour). Search times for vegetated search areas will vary, but should be slow enough to thoroughly search the area and result in high searcher efficiency. Times spent surveying each turbine should be recorded daily.
3) Fatality monitoring should commence at sunrise and the surveys completed for all turbines within 8 hours.
4) All information gathered (i.e. specimen location, species, transect, etc.) should be entered on the enclosed data sheets.
5) Any large fatality events (per search/turbine) of 5 or more and any single fatality of any eagle, or listed species needs to be reported to the DNR Regional Environmental Assessment Ecologist and Energy Facility Permitting within 24 hours.
6) Separate data sheets will be used for each survey date. All carcasses are to be picked up and bagged upon discovery. Injured/crippled birds or bats are collected and considered as a fatality for data purposes. They are to be identified, handled, and labeled properly with the date, turbine number, transect number, and unique specimen number. The specimen should be frozen for use in the scavenger removal and searcher efficiency trials.
7) All specimens located should have an azimuth from and distance to the turbine that is recorded on the data sheet. A numbered flag can be used for each specimen and the distance and azimuth can be recorded upon completion of transect searches, so long as flags are removed after each day/turbine.
8) Each carcass should have a digital photograph taken and time of death estimated.
9) A summary report of this monitoring, including all data sheets and maps should be submitted by January 1 of each year to the DNR Regional Environmental Assessment Ecologist and should be submitted in accordance with the PUC permit requirements.

**Standard Fatality Transect Surveys**

The basis for the methods to be followed for this procedure are set forth by Erickson 2003a, 2003b, Bats and Wind Energy Cooperative 2005 final report, and Kerns and Kerlinger 2004. Turbine search areas should be mapped and labeled into 1 of 4 visibility classes. All visibility classes represented should be included in the map and proportion of each noted in report. Each visibility class will be equally tested for scavenger removal and searcher efficiency trials using carcasses resulting from fatalities at the site (if available).

**Visibility Classes:** Each turbine will have the vegetation in the searchable area defined into one of the following 4 visibility classes and mapped for submission.

- **Class 1** (easy): Bare ground 90% or greater; all ground cover sparse and 6 inches or less in height (i.e. gravel pad or dirt road).
- **Class 2** (moderate): Bare ground 25% or greater; all ground cover 6 inches or less in height and mostly sparse.
- **Class 3** (difficult): Bare ground 25% or less; 25% or less of ground cover over 12 inches in height.
- **Class 4** (very difficult): Little or no bare ground; more than 25% of ground cover over 12 inches in height.

1) Following the establishment of searchable areas, the breakdown of this area into visibility classes, and mapping of each turbine, transects should be established at no greater than 6 meters apart and marked every 10 meters.
2) Each transect will be walked while searching ½ of the distance between transects.
3) As transects are searched, carcasses should be bagged and labeled properly (date, turbine number, transect number, carcass number) and a numbered flag placed in their place. At completion of each turbine, the distance and bearing from each turbine should be recorded and then all flags removed.
4) Searches will be abandoned if severe weather is present, and continue if it clears. The time spent searching at all turbines will be recorded and should be consistent.
Validation Guidelines

Performing scavenger removal and searcher efficiency trials are the standard methods performed to correct for bias in data collection. Below are accepted techniques to perform this correction.

Scavenger Removal Trials

Because there are numerous variables that may make every turbine unique, we suggest placing an equal number of carcasses per turbine to be monitored for removal by scavengers. Additionally, all 4 visibility classes should have a sample size equal to the percentage of that visibility class (ex. 60% of search area of Class 1 gets 60% of the carcasses placed). A random bearing and distance from the turbine should be selected to determine placement of the carcass. For these trials, carcasses must be placed within the surveyed area underneath turbines after sunset and under darkness, and monitored for removal every 24 hours. If possible, fresh carcasses or ones frozen for a limited amount of time should be used. The use of older/dried out carcasses may bias the results because they might not be scavenged at the same rate as fresh ones. The carcasses should be left in place for a 14 day trial length. Ideally, the total number of bird and bat carcasses used should be representative of the actual size and species of killed animals, with no less than 50 specimens monitored per year. If possible, scavenger removal rates should be determined separately for birds and bats due to potential differences in scavenger removal rates. The number of specimens used for scavenger removal trials should be increased when visibility classes are considerably different in vegetation height and density by using 50 per major visibility class. These trials should be performed periodically throughout the season to account for varying conditions. Before placement, each carcass must be uniquely marked in a manner that does not cause additional attraction and have its location recorded. Records shall include the turbine number, a brief description of immediate vegetation that may impede visibility, classification using one of the 4 visibility classes described above, and length of time before removal.

Searcher Efficiency Trials

To produce the best estimates of fatality, a high number of searcher efficiency trials will be performed. A minimum of 100 individual trials per survey year will be performed to test searchers. If possible, searcher efficiency should be determined separately for birds and bats as detection rates of bats may be lower than birds. The carcasses will be numbered and toe clipped for identification with no more than 2 placed at any one turbine per trial. Carcasses missed by searchers will be picked up after the efficiency trial ends. The use of new fatality estimators may require the carcasses remain in place for several searches in order to replicate how searchers find carcasses. The habitat surrounding turbines may vary considerably and searcher efficiency appears highly correlated to visibility and habitat types. Therefore, the search area defined for each turbine surveyed will be divided into the 4 visibility classes. The distribution of carcasses is based on the percentage of each visibility class and will be placed at a random azimuth and
distance. Each turbine monitored by searchers should be examined, with an equal number of carcasses placed at each turbine.

Testing should occur sporadically throughout monitoring periods and searchers must not be made aware they are being tested. An effort should be made to test searchers equally during both inclement and good weather, with weather conditions recorded. Carcasses placed should be representative of the percentage and number of species found during the fatality monitoring, and should replicate the manner in which the majority are found in that visibility class (i.e. crawled under vegetation). An effort to maximize the number of carcasses placed is best, with no less than 100 per survey year. If searcher efficiency is low (<30%) based on initial trials then the search time should be increased, distance between transects reduced, or additional staff training should be conducted.

**Estimators of Fatalities**

Fatality estimators are known to vary considerably from one method to another. For valid fatality estimates only the most contemporary equations should be used as some of the original versions may be biased under some circumstances. The equations used in various estimators are currently being tested and refined and may change over time. The estimator used may also be influenced by the number of search days per week used on the project. Strickland (2011) discussed estimators in The Comprehensive Guide To Studying Wind Energy/Wildlife Interactions. The DNR recommends using the Manuela Huso estimator (Arnett 2009) and two other modern methods for comparison purposes. The Huso method should be adjusted to leave searcher efficiency trial carcasses in the field over multiple searches in order to improve the probability of searcher detection. The Erickson method (Erickson 2004) can be used in order to compare fatality results to other projects that have used that estimator. Standardization of the estimators is essential when comparing fatality estimates from project to project.

**Fatality Monitoring For Moderate Risk Sites**

Monitoring methods for moderate risk sites are designed to collect information on fatalities for project areas with no state listed species known to occur in the area, fewer large blocks of habitat exist, and locations of migratory or local flyways are unknown in the area. The moderate risk methods are designed to determine if fatalities are higher than expected or if listed species are being killed even though no pre-existing records were known. The Agencies may recommend additional monitoring using the high risk methods if fatalities are high or listed species are killed.

The moderate risk methods are the same as the high risk methods except for the following modifications:

1) Minimum of 2 search days per week with a minimum of 2 days separating each search day.
2) Monitoring is conducted for 1 year or more.
3) Search area of 80 m (160 m per rectangular side) in all cardinal directions from the base of the turbine.
4) Searcher efficiency trials using a minimum of 75 carcasses placed.
Fatality Monitoring For Low Risk Sites

The DNR encourages developers to locate projects in the lowest risk areas. If fatality monitoring is voluntarily conducted at low risk sites, the DNR suggests the methods outlined below to ensure a consistent approach and comparable data between wind projects. Monitoring methods suggested for low risk sites are designed to collect information on fatalities for project areas with no state-listed species concerns, little to no large blocks of habitat, and no known migratory or local flyways.

1) Minimum of 1 year of searches.
2) Minimum of one search day per week with a minimum of 3 days of separation between searches.
3) Minimum number of turbines searched is 10.
4) Search area of 80 m (160 m per rectangular side) in all cardinal directions from the base of the turbine.
5) Search time periods covering the peak fatality periods of March 15-June 15 and August 1-October 15.
6) Searcher efficiency trials using a minimum of 75 placed carcasses.
7) Scavenger removal trials using a minimum of 50.

Monitoring of low risk sites is considered baseline data collection to determine if avian or bat fatalities are greater than anticipated. Additional monitoring may be recommended if fatalities are high or if state-listed species are killed. Data collected using low risk site methods should not be used to draw strong conclusions concerning fatalities at the site or be extrapolated to predict fatalities at adjacent wind farms due to the limited monitoring that is conducted.

Data Collection and Reports

Data collection forms are provided as Appendix A and should be used in order to compare data from project to project. The Fatality Report Guidelines (Appendix B) will enable the results and data to be collected in a consistent manner that can then be used to assess known impacts and refine future projects. The data needs to be reported using the Fatality Report Guidelines in order to facilitate the comparison of data among projects. Annual and final reports are recommended along with ongoing dialogue with the Agencies. Data should be provided to the Natural Heritage Review Coordinator (651-259-5109) in electronic format/disc for entry into various DNR databases.
References


Erickson, W.P. 2008. Fatality Impacts to Birds and Bats. NWCC Wildlife Workgroup Research Meeting VII. Milwaukee, WI.


Protocol Version: October 2, 2012
Appendix A

Minnesota Department of Natural Resources

Ecological and Water Resources

AVIAN AND BAT FATALITY SURVEY REPORT

Project Name: _____________________________________________________
Project Location: ___________________________________________________

Company/
Organization/
Name: ___________________________________________________________

Address: __________________________________________________________
                                                      __________________________________
                                                      __________________________________

Phone: (_____)_______-_______  Fax: (_____)_______-_______

E-Mail: ____________________________________________________________

Project Supervisor Name: ____________________________________________

Supervisor Contact:  Phone: (_____)____________________
                                                      E-Mail: ________________________________

If this is contracted work, provide the name & address of the individual/organization work is
being performed for:

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
GPS Locations of All Wind Turbines
(Provide Lat/Lon coordinates in UTM Zone 15N NAD83)

Project Name:______________________________

Total No. of Turbines:________

Lat/Lon GPS Location Information for All Turbines.

<table>
<thead>
<tr>
<th>Turbine No.</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>
Description of Wind Turbine Searched for Carcasses

Project Name: _______________________________  Turbine Number: ________________

1. Diameter of Blade Span: _________ m

2. Blade Height Above Ground- Max.: _________ m;  Min.: _________ m

3. Surface Area of Search Plot: _____________ m²

4. Attach a map of each turbine with 80 meter plot (160 m per rectangular side), search boundaries, location and numbering of transects, and vegetation classification on a separate sheet.

5. Attach a spread sheet with weather data collected at 60-minute intervals. Data should include wind speed, temperature, precipitation, cloud ceiling height, etc.

6. General Habitat Description and Topography within 100 m of Turbine:
   (Use Anderson Classification System)

7. General Habitat Description and Topography >100m to 500m from Turbine:
   (Use Anderson Classification System)

8. Distance of Turbine to High Value Habitat(s) (see DNR Wind Guidance document):
Form Carcass Search 2

MINNESOTA DEPARTMENT OF NATURAL RESOURCES

10/12

Project Name: ________________________

(complete each day of search)

Page: _______ of ________

^Weather:  F= fog, D= drizzle, R= steady rain, W= wind over 10mph

(Use additional Pages as needed)

<table>
<thead>
<tr>
<th>Turbine</th>
<th>Time</th>
<th>Number of Carcasses Found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Number</td>
<td>Observer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Carcass Data Sheet

Observer Name:________________________________
Date:_________________________________________
Project Name:________________________________

Cloud Cover:______%  Temperature: ______°C  Precipitation: _______(fog, drizzle, rain, wind)

<table>
<thead>
<tr>
<th>Time (h)</th>
<th>Turbine No.</th>
<th>Date</th>
<th>Transect No.</th>
<th>Specimen No.</th>
<th>Bat</th>
<th>Bird</th>
<th>Azimuth</th>
<th>Dist. (m)</th>
<th>Species</th>
<th>Age</th>
<th>Sex</th>
<th>Condition</th>
</tr>
</thead>
</table>

*Carcass Number= Turbine # - Date - Transect No. - Sequential Specimen No.;  
*Age= A (adult), J (juvenile) Unk (unknown);  
*Sex= M(male), F(female), Unk (unknown);  
*Condition: E= excellent, F= fair, P= poor.
Appendix B

MINNESOTA DEPARTMENT OF NATURAL RESOURCES

FATALITY REPORT GUIDELINES

• Below is an outlined guide of what should be reported in the annual and final post-construction reports.
• Some general guidelines include:
  o Explain all methods used in detail.
  o If species codes are used, we recommend the American Ornithologist Union 4-letter codes (http://www.birdpop.org/AlphaCodes.htm).
  o Provide all equations and methods used for all calculations.
  o Provide average, range, confidence intervals, $p$ values, and other statistics where applicable.
  o Provide raw data as Appendices or as accompanying files on a CD to the Natural Heritage Review Coordinator (651-259-5109).
• For final reports, include all years of study reporting on each individual year, as well as overall results and trends, detailing any similarities and/or difference between years of study.
• All reports should be submitted by January 1 following that years data collection. Reports need to be sent to the DNR Regional Environmental Assessment Ecologist, Natural Heritage Review Coordinator, and Energy Facilities Permitting.

1. **Executive Summary**

2. **Introduction**
   a. Description of project area
      i. Map of site including turbine locations, roads, transmission lines, substation, etc.
      ii. Distribution, number and size of turbines (height, MW, rotor swept zone, etc.)
      iii. Location of project (state, county, township, etc.)
      iv. Any other general information
   b. Habitat/landcover
      i. Landcover types – map and percentages of each
      ii. High Value habitats identified as per DNR Wind Guidance document.
   c. Wind speed
      i. Overall wind speed and direction (wind rose)
      ii. Prevailing winds from which direction and what times of the year

3. **Methods**
   a. Carcass searches
      i. Turbines & search area
         1. No. turbines searched
         2. How turbines selected
         3. Dates of survey
         4. Time of day searched
         5. Maps of each turbine’s search plot delineating vegetation classes and habitat
         6. Table showing searchable area in each vegetation class for each turbine
      ii. Search methods
      iii. Incidental kills – how documented
   b. Fatality Patterns
      i. Temporal patterns - seasonal
      ii. Spatial patterns - distance from turbine
      iii. Weather and generation associations - how collected and analyzed
         1. Temperature
2. Wind speed
3. Other variables (MW, rotor sweep zone, etc.)
   iv. Species, age, and gender
c. Fatality estimates and adjustment—methods used (Erickson, Manuela Huso, & others) showing all equations used
   i. Searcher efficiency trials & scavenger removal trials
      1. Searcher efficiency methods
      2. Scavenger removal methods
      3. Searcher efficiency and scavenging removal corrections (SESR) – methods and equations used
   ii. Searchable area corrections
d. Fatality and habitat (landcover) correlations

4. Results
   a. Carcass searches
      i. Overall data
         1. Summary of search effort
            a. Average time each turbine searched
            b. # days surveys conducted
            c. Explanation why any days and/or turbines were not surveyed
         2. Bird carcasses
            a. Total No. found
            b. Breakdown by turbine
            c. Breakdown by species
            d. Breakdown by date, month, etc.
            e. Alive, injured, sent to rehab, etc.
         3. Bat carcasses
            a. Total No. found
            b. Breakdown by turbine
            c. Breakdown by species
            d. Breakdown by date, month, etc.
            e. Alive, injured, sent to rehab, etc.
      4. Maps showing carcass location at each search turbine, broken down in 10 m increments; any trends?
         ii. Temporal patterns - Seasonal distribution of fatalities
             1. Day
             2. Week
             3. Month
         iii. Spatial patterns
             1. Distance from turbines
             2. Direction from turbine (showing N, S, E, W)
         iv. Weather and generation associations
             1. Temperature
             2. Wind speed
             3. Other variables (MW, rotor sweep zone, etc.)
         v. Age, species, and gender
             1. Males vs. females
             2. Species
             3. Adults vs. juveniles
   b. Fatality estimates and adjustments (see pages 6–8 for guidance)
      i. Searcher efficiency trials & scavenger removal trials
         1. Searcher efficiency
            a. Overall searcher efficiency average and range
            b. Individual searcher average and range
            c. No. trials and searcher efficiency broken down by bat carcasses, bird carcasses, vegetation class, and date of trial
2. Scavenger removal
   a. Overall average No. days before scavenger removal and range
   b. Average and range of all bat and bird scavenger removal trials
   c. No. trials broken down by bat species and bird species
   d. No. trials and mean scavenger removal broken down by bats & birds, vegetation class, and date of trial
   e. Fresh vs. frozen, intact vs. broken, colored vs. dull (birds), etc. and effects on scavenger removal time if any
   f. Scavenger removal by vegetation class

3. Searcher efficiency and scavenger removal (SESR) Corrections
   ii. Searchable area corrections
   iii. Fatality estimates and adjustments
      1. Bats
         a. Total estimated No. of bats killed at site
         b. Bats/turbine/year include confidence interval
         c. Bats/MW/year include confidence interval
         d. Bats/ft² of rotor area/year include confidence interval
      2. Birds
         a. Total estimated No. of birds killed at site
         b. Birds/turbine/year include confidence interval
         c. Birds/MW/year include confidence interval
         d. Birds/ft² of rotor area/year include confidence interval

3. Turbines with greatest/least kills

4. Other trends?
   c. Correlation of fatalities and Weather data
      i. Temperature
      ii. Wind speed
      iii. Other variables
   d. Note any other trends observed

5. Discussion
   a. Avian fatality
   b. Bat fatality
   c. Implications of results
   d. Suggestions for improvements to protocol
   e. Any recommended adjustments for this site for next year’s surveys
   f. If final report, discuss entire study (both years)

6. Data sheets
   a. Fatality datasheets
      i. Cover
      ii. GPS location of all wind turbines
      iii. Description of wind turbine searched for carcass (using Anderson Level III land cover codes)
      iv. Daily Search Summary
      v. Carcass Data Sheet
   b. Searcher efficiency data
   c. Scavenger removal data
Section 3

Bat Acoustic Survey Protocol for Large Wind Energy Conversion Systems
In Minnesota

Introduction

Acoustic surveys are used to collect data that is used to identify species, relative numbers of bat passes at a particular location, and facilitate the determination of risk of bat fatalities for a proposed wind project. Acoustic surveys may be recommended for projects with potential impacts to bats on a project to project basis. Recommendations will be based on the presence of stream corridors, lakes, wetlands, bat concentration areas, migratory corridors, roosting habitat, and hibernacula within or adjacent to the project area or in close proximity to proposed turbine locations. Understanding bat activity levels prior to construction of wind facilities will assist in identifying habitats and features that may pose a high risk of fatalities to bats and aid with decision-making. The data can be used to determine the overall risk level to bats, specific turbine locations that should be used for fatality searches, and during micro-siting. High numbers of bat passes or higher occurrence of migratory tree bats may result in additional recommendations. In highly problematic projects with high bat kills it may be prudent to consider curtailment or other minimization techniques.

In Minnesota there is limited acoustic and fatality data available and scant information on resident and migratory bats found in the state. Several bat species are being proposed for listing as special concern species in Minnesota and they will increase the need for acoustic data. In addition, white nose syndrome has severely impacted bat species in other states and if found in Minnesota it could result in additional fatalities and bat species listings. Information is lacking in Minnesota for bat migratory corridors, concentration areas, and habitat use for resident and migratory bat species. Additional telemetry studies are needed to improve our knowledge of bat behavior in Minnesota. Bat fatalities have been highly variable among wind energy facilities (Barclay et. al. 2007) and pre-construction acoustic surveys are routinely used to gather data to determine the need for fatality monitoring and assist in turbine siting.

Pre-construction acoustic surveys have been used on numerous projects across the country to gather bat calls that can be identified by using a call library of known vocalizations. Data is used to identify species, relative numbers of bat passes at a particular location, and facilitate estimates of the relative risk to bats from proposed wind turbines. The full-spectrum time expansion and zero-crossing detectors are the two commonly used ultrasound bat detection techniques (see Kunz et.al. 2007 for detailed discussion). The full-spectrum time expansion detector is preferred due to its ability to increase species discrimination when compared to the zero-crossing detector.

Bat acoustic data is one factor used to determine the risk level to bats as it provides baseline data for species present and activity levels within the project area. Additional factors used to determine
risk level are: potential foraging, roosting and maternity habitat in or near the project area, presence of special concern bat species, and known locations of bat hibernacula. Initial overall risk level of a project may be adjusted based on the infrastructure layout, avoidance of high risk portions of the project area, and acoustic data. However, the risk determination does not guarantee that sites with low levels of activity will result in fewer deaths than sites with higher levels of activity (Vonhof 2002).

Bat activity can be highly variable spatially and temporally (Manley et.al. 2006) and this is why acoustic data needs to be collected on individual projects. Attempting to draw correlations from acoustic data from other wind sites and applying it to unstudied sites is not recommended. Movements of bats feeding in or passing through the site should be characterized using acoustical detectors. Acoustic detectors allow researchers to detect and record calls of echolocating bats that can be used to assess relative activity and identify species or groups of species (Arnett et al. 2006).

High fatalities to bats in forested ridge tops on the east coast have been documented on numerous wind project areas. Until recently it was believed that projects dominated by an agricultural landscape would have low bat fatalities. However, in recent years some projects in agricultural dominated areas have indicated that fatality rates are higher than anticipated. Jain (2005) reported estimated fatalities at the Top of Iowa wind farm as being high when compared to other projects in the Midwest and believed their data reflects a real difference in fatality rates. The Summerview site in Alberta, Canada is an agricultural dominated landscape that has also documented high bat fatalities at 18.48 corrected annual per turbine (Barclay et al. 2007). Therefore, it is plausible that bat fatalities in agricultural dominated areas of Minnesota may be higher than expected at some wind project sites.

**Methods**

The number and distribution of sampling stations necessary to adequately estimate bat activity has not been well established but will depend, at least in part on the size of the project area, variability of habitat within the project area, and whether the surveys are being conducted early in the process prior to turbine layout or are being used to assess particular proposed turbine locations. Detectors should be placed on all temporary and permanent meteorological towers for general project area information. Additional portable/temporary towers should be installed at potential high use bat habitat such as stream corridors, forested edges, lakes, or wetlands. Acoustic detectors may be needed for turbines proposed in or immediately adjacent to potential high bat use areas because habitat associated with existing MET towers may not be representative of the habitat associated with proposed turbine locations. As such, the number of bat passes and species identified could vary based on detector location within the project area. Coordination should occur early in the planning process to determine detector locations that are associated with specific habitat features that may attract higher numbers of bats to an area.

Detectors should be situated to sample as much of the rotor swept area (RSA) as possible or at least 150 feet above ground surface (NY State Department of Environmental Conservation, 2009). The location of “low” position sampling is not recommended at this time as it is unclear from existing
data whether those locations would be representative of bat activity in the rotor swept area (RSA) where fatalities occur (Jain 2005).

The predominance of bat fatalities detected to date are migratory species and acoustic monitoring should adequately cover periods of migration and periods of known high activity for resident species (U.S. Fish and Wildlife Service Land Based Wind Energy Guidelines 2012). Based on a limited amount of evidence, migration events may be highly pulsed (Grover 2009) and data collection needs to account for the variability in activity. In Minnesota, the survey period should run from April 1 through October 15. This time period is consistent with data collection on other projects as reported by Arnett (2006). This time period also coincides with known locations of migratory tree bats in Minnesota (red, hoary, and silver-haired) as reported by Cryan (2003).

Recordings at all detectors should occur daily from one half hour prior to sunset until one half hour after sunrise to correspond with bat foraging activity. Data on environmental variables such as temperature and wind speed should be collected concurrently with acoustic monitoring so weather data can be used in the analysis of bat activity levels. Detectors should be visited weekly in order to ensure the units are working properly and to recover data as this will prevent large gaps of data collection due to system failure.

On rare occasion mist netting, harp traps, and hibernacula surveys may be conducted by the DNR or be recommended. Specific methods would be required in order to ensure the proper identification, handling, and equipment sterilization techniques are adhered to. A DNR Special Permit (Scientific & Research) would be required for the qualified bat surveyor.

**Reports**

Reports should be submitted shortly after data collection. A report should be submitted that includes the detailed methods: equipment used, start and end date, height of detector(s), map of detector location(s), and any other pertinent information. The reports should be specific and include calls per hour, calls per day graphed, calls by species/species group graphed, filtering parameters, percent of unverified/filtered calls, any potential relationship to high value habitat (i.e. large blocks of grassland/forest, stream corridors, wetlands, hibernacula) influences on detector location(s), influence of weather on calls, and any other pertinent information. As a minimum the report should break data into high and low frequency calls in all graphs and tables. Arnett (2006) provides a good example of the type of graphs and tables that would be appropriate for reports. Reports should be submitted to the DNR and Energy Facility Permitting (EFP) in a timely fashion. Data should also be provided to the DNR Natural Heritage Review Coordinator (651-259-5109) in electronic format for entry into various DNR databases.
Protocol Summary

1) Detectors should be placed on all temporary and permanent meteorological towers.
2) Additional detectors (in addition to meteorological towers) should be placed in high risk areas.
3) Detectors should be positioned to capture data from the rotor swept zone.
4) Detectors should be operational from April 1 through October 15 (minimum effort).
5) Recordings should occur daily from one half hour prior to sunset until on half hour after sunrise.
6) Reports should be distributed to DNR and EFP in a timely fashion.
7) Raw Data, on disc, should be submitted to the DNR NHIS coordinator.

For detailed methods on equipment, detector deployment, and bat call analysis see Arnett (2006) or Vonhof (2002).
References


Protocol Version: October 2, 2012
Section 4

Avian Flight Characteristics Survey Protocol for Large Wind Energy Conversion Systems in Minnesota

Introduction

Data on avian flight characteristics is used to determine avian use in a wind project area or in relation to proposed turbine locations. Avian use data can be used to determine if concentrated flight paths exist, if birds are flying within the rotor swept zone (RSZ), fatality risk, and species presence in the project area with an emphasis on listed species or Species of Greatest Conservation Need (SGCN). Early coordination with the Agencies (Department of Natural Resources (DNR), Energy Facility Permitting (EFP), United States Fish & Wildlife Service (USFWS) is encouraged in order to discuss the methods and determine the observation station locations. Surveys should be completed by an experienced ornithologist.

In some instances avian wetland use surveys should be conducted concurrently with avian flight characteristic surveys. This provides another opportunity to verify listed species or SGCN in the area that might not be identified at the observation stations or during other avian surveys. In addition, it provides verification to the flight characteristic data in terms of cross checking flight paths to known concentrations of avian species.

Methods

The starting date of spring surveys is March 15 and end date June 15. The surveys are designed to start March 15 to obtain data on migratory species and continue into May and June to collect information on late migrants and breeding birds. The start date for northern Minnesota can be adjusted depending on ice out and reports on the status of migration in any given year.

Conducting spring surveys is a higher priority than fall surveys due to the potential to locate nesting listed species and the migration is more pronounced in spring than in the fall. However, fall surveys can yield valuable information that can be different than spring surveys due to changing habitat conditions, different migratory paths, and variability in prey abundance and locations. Changing habitat conditions can be the harvest/plowing of agricultural fields, fluctuations in wetland water levels, and varying use of habitat based on inclement weather conditions. Fall surveys should be conducted from August 1 through November 15. The survey period is designed to capture shorebirds and other species that migrate early and continue through the major migration period for most species. If the project area does not contain potential shorebird habitat then surveys could start on September 1.

Surveys can be conducted under variable weather conditions except when visibility is reduced to less than 600 feet due to dense fog, rain, or snow or the conditions are unsafe for the observer. Conducting surveys under varying weather conditions will provide better data concerning the birds being in the rotor swept zone as weather can affect the height of bird flight.
Locations

The number of observation stations is determined on a project-by-project basis depending on the objectives of the data collection and potential number of flight paths. In most instances the observation stations are located at vantage points along suspected flight paths. Suspected flight paths can occur where waterfowl, shorebirds, colonial nesting birds, or other species are likely to fly among wetlands or lakes. The observation stations are located close to the area of avian concentration because that increases the likelihood of verifying a defined flight corridor. River corridors are also likely flight paths for numerous species and should be taken into account when determining the observation stations. Large stick nest building species (i.e. bald eagles, herons) can also be tracked from their nests to foraging locations. Observation station locations should be coordinated with the Agencies prior to data collection in order to target areas of concern.

All large stick nests should be identified and observed to determine species occupancy. If bald eagles are observed in the area it should be reported to the USFWS as they may have additional survey requirements under the Bald and Golden Eagle Protection Act.

Frequency

Each observation station is surveyed 1 time per week for 1 hour per visit starting either at sunrise to 10 AM or 3 hours prior to sunset. Survey times should be alternated among sunrise and sunset for each observation station. Daily field data sheets should be included in the appendix of the Flight Characteristics Report.

Osborn et al. (1998) used 8, 10-min counts over 2 hours during each time period of morning, midday, and evening for a total of 240 minutes for each day of surveying during 1994 and 1995 in the Buffalo Ridge Wind Resource Area. Johnson et al. (2000) surveyed for large bird species on Buffalo Ridge, Minnesota using 1 hour of survey time every two weeks with ½ hour in the morning and ½ hour in the afternoon for each observation station from March 15 to November 15. Young et al. (2002) surveyed 8 observation stations for 30 minutes per station once per week over a continuous 1 year period. Two of the surveys were conducted from spring through fall and one surveyed during all seasons including winter in order to gather enough data to draw meaningful conclusions. Krych et al. (2010) surveyed for 50 minutes per station once per week from April through June using methods coordinated with the DNR.

The amount of survey time must be high enough to elucidate flight paths, birds within the rotor swept zone, and rare species presence. Based on the above references and practical experience the minimum time per observation station to gather enough data, using a short (12 week) data collection period starting March 15 is 1 hour for each observation station once per week.
Data Collection

Binoculars are used to collect data in all directions from the observation station to approximately 1 mile for large species and less for smaller species. Data should be recorded for all birds seen with as many positive species identifications as possible. Appendix A contains an example of a data sheet that can be used during the surveys. If species identification is not possible the individuals should be recorded as unknown, but still recorded. If suspected flight paths are observed at locations too far to collect data on or determine flight paths then additional observation stations can be established. This flexibility is worked into the methods to allow for adapting data collection based on field observations.

Rangefinders and reference points are used to assist with determining distance from observation station and mapping. Meteorological towers can be used as a reference height for determining the bird height in relation to the RSZ. Observers should become familiar with estimating RSZ prior to data collection.

All avian species observed during each survey period are assigned a unique observation number. Raptors, large birds, special concern species, and listed species are plotted on a map. Flight paths are mapped and given the corresponding unique observation number. If a preliminary turbine layout is available then data should be collected on how far the bird is from proposed turbines.

Protocol Summary

1) Spring flight path survey time is from March 15 to June 15.
2) Fall flight path survey time is from August 1 to November 15.
3) Surveys conducted under variable weather conditions.
4) Number and location of observation stations determined in consultation with the Agencies.
5) Each observation station is surveyed 1 time per week for 1 hour per visit starting either at sunrise to 10 AM or 3 hours prior to sunset.
6) Reports/results provided and discussed with the Agencies.

Reports

The data is used to generate a report that should be provided to the Agencies and discussed prior to or during the initial turbine layouts. The report should use the common and scientific names throughout the document. If species codes are used, we recommend the American Ornithologist Union 4-letter codes (http://www.birdpop.org/AlphaCodes.htm). The report should include the following maps: observation stations, SGCN/listed species flight paths, waterfowl migration flight paths, waterfowl nesting flight paths, raptor flight paths, colonial nesting species flight paths, and other flight paths as appropriate. Figure 1 contains an example of how to map flight paths. Common generalist species (i.e. crows, pigeons) do not need to be mapped. Text associated with each map should indicate the percent of the observations with birds being within the RSZ during the observation period. Avian flight path data sheets (Appendix A) should be included as an appendix of the report. Data should also be provided to the DNR Natural Heritage Review Coordinator (651-259-5109) in electronic format for entry into various DNR databases.
References


Protocol Version: October 2, 2012
### Appendix A

#### Avian Flight Path Data Sheet

<table>
<thead>
<tr>
<th>Project Name/Number:</th>
<th>Station:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Time:</td>
<td>End time:</td>
</tr>
<tr>
<td>Date:</td>
<td>Observer:</td>
</tr>
<tr>
<td>Wind:</td>
<td>Wind Direction:</td>
</tr>
<tr>
<td>Sky:</td>
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<table>
<thead>
<tr>
<th>Sky</th>
<th>Behavior</th>
<th>Interval (Min.)</th>
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<tr>
<td>0</td>
<td>&lt;10% Clouds</td>
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**Wind**

- 0 = No wind
- 1 = Leaves barely move, 1-3 mph
- 2 = Leaves rustle, small twigs move, 4-7 mph
- 3 = Leaves, twigs in constant motion, 8-12 mph
- 4 = Small branches move, 13-17 mph
- 5 = Large branches and small trees sway, 18-24 mph
- 6 = Large branches in constant motion, >25 mph

#### Species Data

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1. **Direction from Observation Station.**  
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3. Only collected if proposed turbine locations exist during surveys.
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1. Direction from Observation Station.
2. Distance from Observation Station.
3. Only collected if proposed turbine locations exist during surveys.
Figure 1
Section 5

Avian Grassland Survey Protocol for Large Wind Energy Conversion Systems

In Minnesota

Introduction

Grassland bird surveys are used to gather information on species presence and relative abundance within or immediately adjacent to the project area during the nesting season. Grassland bird surveys may be recommended by the Agencies (Department of Natural Resources, Energy Facility Permitting, and United States Fish & Wildlife Service) on a project by project basis. Habitat identification for surveys is based on past records of occurrence, habitat patch size(s), association among patches, and relation of the patch(s) to the project boundary. Grassland survey data is used to determine the risk level of the project, infrastructure layout, and turbines to include for fatality monitoring. Wind project infrastructure located in or adjacent to grassland habitat can result in direct habitat impacts, displacement/avoidance of habitat, and increased potential for fatalities.

Surveys should be conducted by qualified ornithologists on the DNR surveyor list that can be obtained from the Natural Heritage Review Coordinator (651-259-5109). Coordination concerning the surveys should occur early in the process to identify the habitat to be surveyed. Conducting the surveys early in the process allows for the avoidance and minimization of impacts and reduces the likelihood of infrastructure (turbines, access roads, substations, collector lines) layout changes later in the process.

All species identified are recorded; however, the emphasis is to locate Species of Greatest Conservation Need (SGCN) and state or federal listed species. The surveys are used to gather additional data to determine the continued species existence at past locations and find new locations. Some grassland species like the upland sandpiper (Mixon 2006) and short-eared owl (Mixon 2004) require different methods to achieve an increased likelihood of detectability and those methods will be outlined by the Agencies on a project by project basis. Coordination with the Natural Heritage Review Coordinator is required as they may recommend additional species specific survey methods for some species. Observation of non-grassland species are recorded during the surveys to include any raptor nests observed during the surveys or while at other locations within the wind project area.

Most listed grassland species are more habitat specific and require larger blocks of habitat for nesting. Surveys for grassland species should be concentrated in the larger blocks of habitat or areas with past records of species presence. Typically, surveys are conducted on public land, Conservation Reserve Program, Reinvest In Minnesota, prairie, or other areas that are less disturbed and fragmented. The DNR recommends that surveys be focused on potential habitat for SGCN and state or federal listed species. General point counts along roads and disturbed areas (i.e. farm fields) are usually not a valid method, when used alone, for determining the presence of listed species. General point counts along roads typically provide a list of generalist avian species that use fragmented habitat. The Agencies will identify potential habitat, in consultation with the project proponent, that should be surveyed. Under some circumstances, the Agencies may not recommend species surveys if potential habitat is avoided and an appropriate buffer is applied.
When assessing data in relation to project infrastructure it is important to note the impacts are not limited to project infrastructure located within grassland. Infrastructure located adjacent to the grassland habitat can result in fatalities or habitat avoidance. Following are common scenario’s that result in grassland species utilizing habitat adjacent to secure nesting cover or throughout a project area:

* When grassland birds arrive in the spring they are migrating into the area and moving among patches of potential nesting habitat and that may put them in contact with turbines. The risk may be even greater to first year nesting birds as they tend to investigate more areas as potential nesting habitat when compared to pairs that were successful in prior years and have developed site fidelity.

*Prior to migration, in late summer/early fall, the adults and young of the year will begin to disperse from nesting habitat to various patch sizes of grasslands, wetlands, and agricultural fields in the area. The increased activity and dispersal increases the fatality risk due to a greater likelihood of birds being within the turbine rotor swept zone.

*Many grassland birds nest several times during a breeding season and can relocate to other fields for nesting, especially if a nest has been destroyed by predators, mowing, grazing, or plowing. The movement among habitat patches may increase fatality risk.

In order to assess potential impacts to grassland birds specific survey methods are needed in order to determine their presence/absence in nesting habitat, determine the avian risk level, use in micro-siting, and provide information on the need for fatality searches.

**Methods**

Grassland bird species are surveyed using transects in large blocks of un-fragmented grassland habitat during the nesting season. The number of transects are determined on a project by project basis and are established to have full coverage of the grassland habitat. Transects are established, relocated, and followed using GPS units with pre-recorded waypoints. Generally the transect covers 75-meters (m) either side of the transect line for a total width of 150-m. Transects are spaced approximately 250–m apart and 150-m from the edge of a habitat. In very large blocks of grassland the number and spacing of transects may need to be adjusted. Observer’s record observations for 100-m segments along each transect. For each 100-m segment the observer walks slow enough to hear and see birds. The observer stops for 5 minutes at the beginning and end of each 100-m segment to listen and spot birds.

Three surveys are conducted, from 15 minutes prior to sunrise to 10 AM, with one survey occurring during the last week of May, first week of June, and third week in June. Surveys are timed to coincide with the most active period within the nesting season for most grassland species. Conducting surveys outside of these dates may produce unreliable data that may not be accepted by the Agencies. Surveys are only conducted in weather favorable to hearing and seeing the species (low wind <10 mph, no rain).

In addition to the species observed (call or visual) and location, the following data are recorded for each transect survey: Date, start and end time of observation period, transect number, number of individuals, distance from observer, behavior, first altitude above ground, flight direction, and weather (temperature, wind speed, wind direction, precipitation, and cloud cover).
Recommended methods are a combination of techniques used by the Pennsylvania Game Commission (2007), Minnesota County Biological Survey (2010), Graham Environmental Services Inc. (2009), and Western Ecosystems Technology Inc. (2008).

Protocol Summary

1) Identification of habitat to be surveyed and establishment of transects.
2) Three surveys during last week of May, first and third week of June.
3) Surveys are conducted from 15 minutes prior to sunrise to 10 AM.
4) Transects are spaced approximately 250 –m apart and 150-m from the edge of a habitat. Observer’s record observations for 100-m segments along each transect. The observer stops for 5 minutes at the beginning and end of each 100-m segment.

Report

Further coordination with the Agencies regarding survey results should occur to determine if additional avoidance and minimization are needed. A final survey report that includes proposed avoidance and minimization measures should be generated and provided to the Agencies. The surveys and final report should be completed early in the site planning stage of the project. If species codes are used, we recommend the American Ornithologist Union 4-letter codes [http://www.birdpop.org/AlphaCodes.htm](http://www.birdpop.org/AlphaCodes.htm). The report should include the following maps: habitat patches surveyed and transect locations, locations of SGCN/listed species, grassland bird concentration areas, raptor observations and general flight paths, and other maps as appropriate. Common generalist species (i.e. crows, pigeons) do not need to be mapped. Grassland survey data sheets should be included as an appendix of the report. Text of the report should discuss species known to avoid turbines or access roads, fragmentation of habitat, proximity of turbines to surveyed habitat patches, and any other relevant information. Data should also be provided to the DNR Natural Heritage Review Coordinator (651-259-5109) in electronic format for entry into various DNR databases.

In some instances avian wetland use surveys should be conducted concurrently with grassland bird surveys. Avian wetland use surveys provide another opportunity to verify listed species or SGCN in the area that might not be identified during the grassland bird surveys or during other avian surveys.
References

Graham Environmental Services, Inc. 2009. Oak Glen Wind Farm Project Loggerhead Shrike and Henslow’s Sparrow Surveys. Prepared for Merjent, Inc.


Protocol Version: October 2, 2012
Section 6

Avian Wetland Use Survey Protocol for Large Wind Energy Conversion Systems

In Minnesota

Introduction

Avian surveys of large lakes or wetlands, with an open water component, are used to establish the presence and relative numbers of avian species within or in close proximity to the project area. The surveys are designed to identify Species in Greatest Conservation Need (SGCN), listed species (state or federal), avian concentrations, species not identified during other survey efforts, and assist with determining project risk level to avian species.

The wetlands surveyed should be coordinated with the Agencies prior to data collection. Note that these surveys are not designed to be conducted for all wetlands, but only the large open water lakes or wetlands that can be surveyed with a reasonable amount of effort. The survey effort is designed to be efficient and limited in scope. In many instances the wetland use surveys can be conducted on the same days as flight path characteristics or grassland bird surveys. When avian use surveys are conducted in combination with avian flight characteristic surveys the data can be used to cross check flight paths to known concentrations of avian species.

Methods

Wetland use surveys should be conducted a minimum of three times from March 15 through June 30. The surveys should be spaced a minimum of 4 weeks apart to cover various migratory periods and early nesting. Each survey should last for a minimum of 60 minutes.

Surveys should be conducted during favorable weather conditions that allows for the observation of open water areas that can be glassed at a distance. Surveys should be conducted from sunrise to 10 AM or 3 hours prior to sunset. If these surveys are being conducted on the same day as the flight characteristic methods then survey times can be flexed outside of the preferred survey times. The flexibility allows for data collection to be conducted on the same day as other surveys.

Reports

Reports should be provided to the Agencies that include the species, species status (SGCN or listing), number of individuals observed for each survey period for each wetland, map of survey locations and any observed flight paths. If species codes are used, we recommend the American Ornithologist Union 4-letter codes (http://www.birdpop.org/AlphaCodes.htm). Data should also be provided to the DNR Natural Heritage Review Coordinator (651-259-5109) in electronic format for entry into various DNR databases.

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