BIRDS AND BIRD HABITATS

Guidelines for Wind Power Projects

October 2010

Developed by:
Ontario Ministry of Natural Resources

Cette publication hautement specialisée "Birds and Bird Habitats : Guidelines for Wind Power Projects" n'est disponible qu'en Anglais en vertu du Règlement 411/97 qui en exempte l'application de la Loi sur les services en français.
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Note: For readability purposes, this guidance document does not include specific references to supporting scientific research. For reference materials and supporting information, please refer to Section 5.0 and Appendix E of this document.

1.0 Introduction

The *Green Energy Act*, 2009 places a priority on expanding Ontario's use of clean and renewable sources of energy such as wind, water, solar and bioenergy. Developing these resources is a cornerstone of the province's plan to reduce the impacts of climate change and to build a greener economy for Ontario.

A key element of the *Green Energy Act* is a coordinated provincial approval process for renewable energy projects. This new process integrates into one process all provincial Ministry requirements for the review and decision making on proposed renewable energy generation facilities. The requirements are outlined under the Ministry of the Environment's *Renewable Energy Approval Regulation (O.Reg. 359/09)*, and the Ministry of Natural Resource's (MNR) *Approval and Permitting Requirements Document*.

The *Renewable Energy Approval Regulation* describes the requirements for wind power projects related to significant natural features, including significant wildlife habitat. Birds are important to Ontario's biodiversity, and their habitats are identified as significant wildlife habitat (SWH) under MNR's *Significant Wildlife Habitat Technical Guide*.

The purpose of this Guideline is to provide guidance on identifying and assessing bird habitat and for addressing potential negative effects on birds and bird habitats during the planning, construction, and operation of onshore wind power projects in Ontario and is applicable to both Crown and private land. This Guideline replaces MNR's *Guideline to Assist in the Review of Wind Power Proposals: Potential Impacts to Birds and Bird Habitats* (2007).

1.1 Potential Effects of Wind Power Projects on Birds

Post construction mortality surveys conducted at wind power projects in Ontario and recent studies undertaken around the world that suggest very low numbers of bird fatalities occur at wind power projects. Reports from wind energy facilities in Ontario and the United States have shown that approximately two birds per year are killed by individual wind turbines, which is very low compared to other existing sources of human-caused avian mortality.

The *Renewable Energy Approval Regulation* and this Guideline focus on consideration and protection of bird SWH when selecting a project location. This approach appears to be a key factor in preventing negative effects on birds and bird habitats. However, there are some knowledge gaps and concerns that still remain relating to disturbance and avoidance and bird migration. This Guideline will assist in identifying and addressing concerns associated with bird SWH and interactions between wind turbines and birds and contribute toward an adaptive management approach to protecting birds and bird habitat.

Wind power projects have the potential to affect birds directly (i.e. collisions, direct mortality) and indirectly (i.e. disturbance and avoidance). A detailed summary of potential effects of wind power projects on birds can be found in *Wind Turbines and Birds: A Background Review for Environmental Assessment* (EC-CWS, 2007a).

Direct Effects

Birds may be injured or killed through collisions with turbine blades and towers, guy wires, meteorological towers, and maintenance vehicles. Mortality may also arise from electrocution or, in nocturnal birds, from physical exhaustion associated with light-induced disorientation.

Three main factors that contribute to avian mortality at a wind power project include:

- density of birds in the area and their behaviours (e.g. flight displays, feeding, etc.);

- landscape features in the area (especially ridges, steep slopes, valleys and landforms such as peninsulas and shorelines that funnel diurnal bird movement); and
- poor weather conditions.

Appropriate selection of a project location is a key factor to preventing potential negative effects on birds.

Indirect Effects

Indirect effects on bird habitat and behaviour are equally important when considering potential adverse effects of wind power projects. Birds may be displaced from suitable habitat by wind power projects at any stage in their annual cycle (e.g. breeding, migration). Displacement may be due to direct loss of feeding, breeding, or migratory stopover habitat during construction and operation of a facility, or to active avoidance of structures, human activity, noise, or infrastructure (e.g. roads, cut forest edges). Quality of breeding habitat may also be diminished by fragmentation effects (e.g. openings in contiguous habitat to accommodate turbines, transmission lines, and service roads) that may lead to changes in predation and parasitism levels or to adverse effects on area-sensitive species. The extent of avoidance behaviour is species-specific, and may lead to reduced energy intake through lost feeding opportunities.

There may also be situations where habitat fragmentation (edge habitat) created by wind power projects may attract more birds into an area and subsequently increase the incidence of birds interacting with wind turbines.

1.2 Regulatory Framework

The *Renewable Energy Approval Regulation* includes requirements to ensure the specific protection of significant natural heritage features, including bird SWH. More generally, the *Renewable Energy Approval Regulation* provides for the ability to establish environmental effects monitoring where a negative environmental effect is likely to occur (paragraph 4 of item 4, Table 1). These requirements apply to class 3, 4, and 5 wind power projects (i.e. those having a name plate capacity of 50 kW or greater).

This Guideline provides both technical guidance and specific direction on how an Applicant for a Renewable Energy Approval can complete the class 3 and 4 wind power project regulatory requirements for birds and bird habitats, including:

- The natural heritage assessment process for identifying natural heritage features and determining whether they require protection under the *Renewable Energy Approval Regulation* (i.e. identifying bird habitats and determining significance);
- The approach to protection outlined in the *Renewable Energy Approval Regulation* where bird SWH has been identified, including environmental effects monitoring for habitat associated with an environmental impact study; and
- Post-construction environmental effects monitoring requirements for potential negative environmental effect on birds (i.e. operational mortality) and additional monitoring and/or mitigation if this monitoring shows a negative environmental effect is occurring at a level that exceeds the significant annual mortality threshold.

1.3 Ministry of Natural Resources Role

Under Section 28 of the *Renewable Energy Approval Regulation*, MNR is responsible for establishing or accepting evaluation criteria and procedures related to natural features, including bird habitat. MNR is also responsible for reviewing all reports related to natural heritage assessments and for confirming that they have been prepared using appropriate evaluation criteria or procedures, such as

those outlined in this Guideline. MNR confirmation is required as part of an application to the Ministry of Environment for a renewable energy approval for a wind power project.

The *Natural Heritage Assessment Guide for Renewable Energy Projects* provides procedures and evaluation criteria for conducting natural heritage assessments and may provide additional procedural guidance relevant to the consideration of bird habitat.

Environment Canada is the federal agency responsible for protection of migratory birds through the administration of the *Migratory Birds Convention Act* and has responsibilities under the federal *Species at Risk Act*. During a federal environmental assessment under the *Canadian Environmental Assessment Act*, Environment Canada will provide advice on migratory birds, federal species at risk (including special concern) and other areas related to its mandate. Where the *Canadian Environmental Assessment Act* is not triggered, MNR advises the applicant to seek migratory bird advice from Environment Canada.

MNR has a responsibility for protecting the habitat of all bird species (migratory and non-migratory) in Ontario. Applicants will be able to more readily advance their projects by working closely with MNR and Environment Canada to ensure that all bird and bird habitat information is identified in advance and collected simultaneously.

The following points should be noted:

- Knowledge and information regarding specific effects to birds and bird habitats in Ontario and our knowledge of bird SWH in the province is limited in some cases but growing.
- Provincially protected/managed birds are the mandated priority for MNR, which include:
    - game birds listed in Schedule 3 of the *Fish and Wildlife Conservation Act*
    - specially protected species (raptors) listed in Schedule 7 of the *Fish and Wildlife Conservation Act*
    - specially protected species (other than raptors) listed in Schedule 8 of the *Fish and Wildlife Conservation Act*
    - all non-migratory bird species
    - all species listed under the *Endangered Species Act (2007)*

This guideline is not intended to replace any species-specific approaches that may be needed to comply with the *Endangered Species Act*. More information regarding the *Endangered Species Act* and how to identify locations for protected bird species and their habitats can be found in Appendix B of the MNR's Approval and Permitting Requirements Document and by contacting a local MNR office.

2.0 Assessment Process for Birds and Bird Habitats

As part of the natural heritage assessment outlined in the *Renewable Energy Approval Regulation* (Sections 24-28), wildlife habitat, including bird habitat, must be considered and addressed. Reports associated with the Natural Heritage Assessment must be submitted to MNR for review and confirmation. Applicants must prepare the following reports:

- Records Review Report
- Site Investigation Report
- Evaluation of Significance Report (if applicable)
- Environmental Impact Study (EIS) Report (if applicable; including a description of mitigation and monitoring outlined in the construction plan report and environmental effects monitoring plan)
- Environmental Effects Monitoring Plan (all projects)

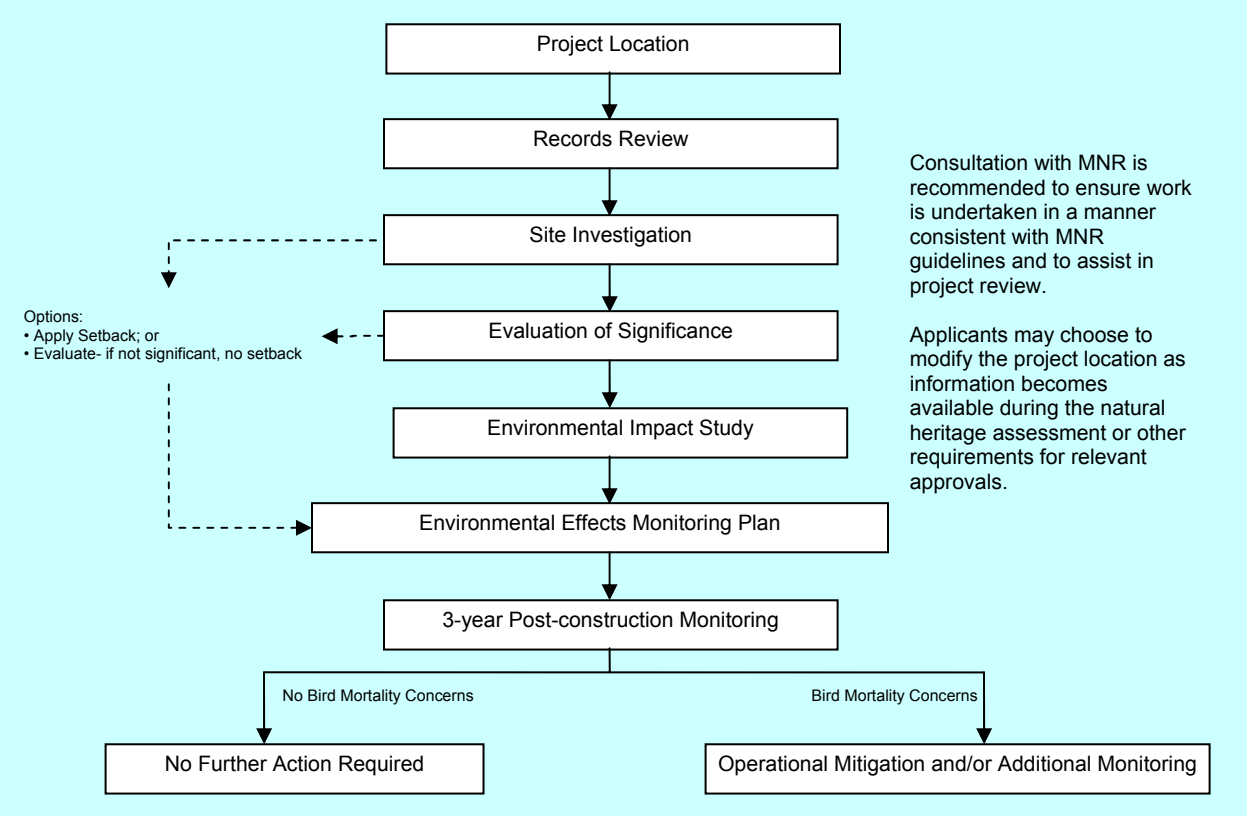
These reports and associated submission procedures are described in the *Renewable Energy Approval Regulation* and Natural Heritage Assessment Guide for Renewable Energy Projects. The reports should provide information on pre-construction assessment and mitigation options, including

maps, field protocols, survey methods and criteria for mitigation implementation. If an EIS is required and mitigation is implemented to reduce the effects of the project on significant bird habitat, habitat-based monitoring is required, and will be outlined in the Environmental Effects Monitoring plan.

Due to the potential negative environmental effects on birds from the operation of wind power projects, three years of annual post-construction bird mortality monitoring is required for all projects. This monitoring will be set out in the Environmental Effects Monitoring Plan. Should post construction monitoring show significant bird mortality (Section 4.2), operational mitigation may be required.

Figure 1 outlines the assessment process for identifying and evaluating bird habitat, addressing the potential negative effects to birds and their habitats and minimizing and monitoring of potential effects. At each stage of the assessment, applicants evaluate new information as it becomes available to identify candidate and confirmed significant wildlife habitat, develop mitigation measures and direct monitoring efforts.

Figure 1. Bird and Bird Habitat Assessment Process (as part of natural heritage assessment).



2.1 Project Location

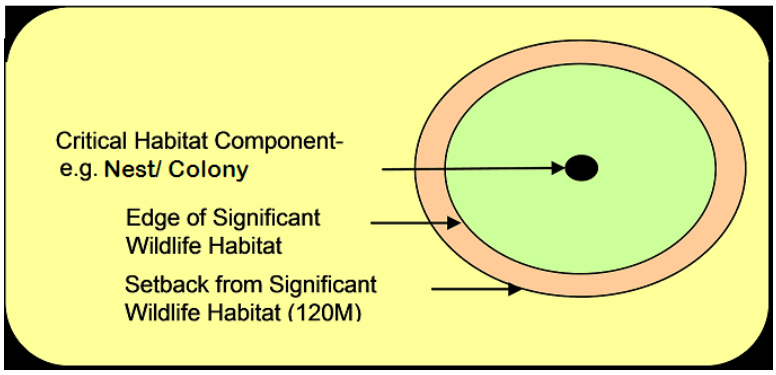
Selecting the location for the project is generally the most important consideration to minimize potential effects to birds and their habitats. Applicants should collect and consider all available bird and bird habitat-related information for the proposed project location.

2.2 Records Review

The Applicant will ensure that a search for and analysis of records are conducted in respect of the air, land and water within 120 metres of the project location, as set out in *Renewable Energy Approval*

Regulation. Wildlife habitat data collected during the records review will frequently identify habitat components (e.g. nest/colony), which appear as points on a map. While these habitat components may originate further than 120 metres from the project location, the associated candidate or confirmed significant wildlife habitat (Figure 2) can extend well beyond the point location itself (in some cases as much as 1000 metres). Applicants should consider and identify habitat components and associated wildlife habitat that may extend to or within 120 metres of the project location during the records review.

Figure 2. Defining Bird Significant Wildlife Habitat



During the Records Review stage of the Natural Heritage Assessment process, applicants will collect all available bird and bird habitat-related information for the proposed project location, including information on bird species, candidate and confirmed bird SWH and other relevant data. MNR will provide the applicant with any known bird information relevant to the project and encourages consideration of additional sources of information (Appendix D). Information collected during the Records Review stage should be confirmed or verified during the Site Investigation and during the Evaluation of Significance (where applicable). In most cases, much of the required detailed project location information will be collected during the Site Investigation and Evaluation of Significance stages.

Bird and bird SWH related information should be collected as early as possible to expedite the Natural Heritage Assessment and renewable energy approvals process. Some of the information requirements for birds and bats are the same, and the applicant may incorporate these into a single collection process to reduce workload.

Records review information will generally include:

Bird and Bird Habitat Data

- species present (or likely) and relevant life cycle/history characteristics
- information on any confirmed SWH
- information on features associated with candidate SWH (e.g. wetlands, ridges, woodlands, major waterbodies)
- habitat types (e.g. Ecological Land Classification)
- other natural heritage features in near proximity to the proposed development
- potential feeding, migration, resting, roosting and nesting areas
- information on species protected under the ESA 2007

Specific information and required records to be searched are outlined in detail in the *Natural Heritage Assessment Guide for Renewable Energy Projects* and *Renewable Energy Approval Regulation*.

The Records Review report should include mapping products and spatial data that identify project location and study area boundaries, habitat types and features (e.g. forest, wetlands, topographic

features, agricultural areas, etc.), existing roads, locations of any candidate or confirmed bird SWH, and distances of project to any features of potential concern.

2.3 Site Investigation

The Applicant will ensure that a physical investigation of the air, land and water within 120 metres of the project location is documented, and determine if additional candidate bird SWH is present. During the site investigation, applicants should consider habitat components originating outside of 120 meters that may have associated candidate bird SWH that extends to or within 120 metres of the project location. Habitat boundaries for candidate and confirmed SWH should be mapped during the site investigation stage and the distance between natural features and project location indicated.

MNR's *Significant Wildlife Habitat Technical Guide* identifies and defines bird SWH, and outlines procedures to assist in completing the Site Investigation Report requirements. It is important to refer to the *Significant Wildlife Habitat Technical Guide* at this stage to identify candidate and confirmed bird SWH.

As outlined in Section 26 of the *Renewable Energy Approval Regulation*, the Site Investigation report should describe:

- Date and times of the beginning and end of Site Investigation and duration of investigation;
- Weather conditions during the Site Investigation;
- A summary of investigation methods;
- The name and qualifications of person(s) who conducted the Site Investigation;
- The field notes kept by site investigators;
- A summary of any corrections made to information collected during the records review (e.g. additional candidate bird SWH identified, etc.);
- Information relating to the type, attributes, composition, function of each bird habitat feature identified; and
- A map showing the boundaries of any identified candidate or confirmed bird habitat within 120 metres of the project location, clearly identifying their distance from the project location.

For unevaluated habitat (i.e. candidate SWH), the applicant may consider those habitats as significant and apply the setback. If an applicant proposes a project location within the candidate bird SWH or setback, the significance of the habitat must be evaluated.

2.4 Evaluation of Significance

As per Section 27 of the Renewable Energy Approval regulation, an applicant who proposes a project location within 120 metres of a candidate or confirmed bird SWH is required to conduct an evaluation of significance. MNR encourages applicants to consider applying setbacks as the first option, prior to moving forward with an evaluation of significance and possibly an EIS.

The Evaluation of Significance report should provide:

- A determination of significance for each natural feature on the Site Investigation map;
- A summary of the evaluation criteria or procedures used in determining significance;
- The names and qualifications of person(s) who applied the evaluation criteria or procedures; and
- The dates of the beginning and completion of the evaluation.

The *Significant Wildlife Habitat Technical Guide* identifies and provides criteria for identifying candidate bird SWH, confirming bird SWH and defining an area that supports the form and function of bird SWH (Figure 2). Criteria from the *Significant Wildlife Habitat Technical Guide* should be used in conjunction with methods found in Appendix B for evaluating significance of bird SWH. Where criteria

for confirming bird SWH are not defined in the *Significant Wildlife Habitat Technical Guide*, bird habitats cannot be evaluated.

If a candidate bird SWH is evaluated and confirmed within the project location, applicants may setback 120m or conduct an Environmental Impact Study (Section 3.0) as part of the Natural Heritage Assessment process to determine whether potential negative environmental effects can be avoided or effectively mitigated.

Applicants are encouraged to contact the local MNR office regarding the evaluation of significance of bird habitats prior to submitting their report, to assist in expediting the Natural Heritage Assessment review process.

3.0 Environmental Impact Study

An Environmental Impact Study (EIS) is required if a project location is proposed within 120 metres of confirmed bird SWH. MNR encourages applicants to consider a setback of 120 metres as the first option. By applying a setback, the applicant is not subject to the EIS requirements outlined in this section.

An EIS must be prepared to address direct and indirect effects related to bird SWH in accordance with procedures established by MNR's Natural Heritage Assessment Guide, describing:

- any negative environmental effects of the project to bird SWH;
- mitigation measures for any negative environmental effects to bird SWH; and
- how the construction plan report and the environmental effects monitoring plan address any negative environmental effects to bird SWH.

The *Significant Wildlife Habitat Technical Guide* and supporting documents provide bird SWH mitigation considerations for renewable energy projects. These documents should be referred to for complete and up to date requirements for bird habitat mitigation.

General approaches to minimizing potential negative effects to birds or bird SWH include:

- careful consideration of project location relative to candidate and confirmed bird SWH;
- avoidance of wind turbine placement near water or in riparian habitat in an otherwise dry area, as bird activity and collisions are expected to be higher in these areas;
- construction at "less-sensitive" times of the year to avoid disturbing natural bird processes and habitat;
- restoration of habitat disturbed during construction

4.0 Environmental Effects Monitoring Plan

The Environmental Effects Monitoring Plan will describe any bird SWH mitigation and monitoring required as determined through the EIS (where applicable). The Natural Heritage Assessment Guide for Renewable Energy Projects provides examples of mitigation measures for potential negative environmental effects associated to bird SWH.

In addition, for all class 3 and 4 wind power projects, the Environmental Effects Monitoring Plan will outline post-construction bird mortality survey requirements for three years to address potential negative environmental effects to birds.

The Environmental Effects Monitoring Plan will also identify subsequent mortality and effects monitoring at individual turbines associated with high mortality (and unmonitored turbines in near proximity) for two years, following any given year where an annual post-construction bird mortality report identifies significant bird or raptor mortality.

Based on the results of monitoring, mitigation options should be considered at individual turbines where a mortality effect has been identified or significant mortality persists. Where mitigation is implemented, three years of effectiveness monitoring is required.

As outlined in Item 4 of Table 1 of the *Renewable Energy Approval Regulation*, the Environmental Effects Monitoring Plan should provide:

- performance objectives related to negative effects to bird SWH;
- mitigation measures to assist in achieving the performance objectives; and
- a program for monitoring negative environmental effects including a contingency plan to be implemented if any mitigation measures fail.

Post-construction monitoring surveys may be conducted in conjunction with post-construction bat surveys.

To avoid any delays in evaluating whether an application is complete, applicants should submit the post-construction monitoring and mitigation plan to MNR in advance of the complete submission. MNR will review the applicant's proposed Environmental Effects Monitoring Plan to ensure that the proposed survey design meets the standards established in Appendix B.

4.1 Mortality Thresholds

A threshold approach will be used to identify and mitigate potential negative environmental effects resulting from the operation of wind turbines (i.e. significant bird mortality).

Bird and raptor mortality is considered by this Guideline to be significant when a threshold of annual bird mortality exceeds:

- 18 birds/ turbine/year at individual turbines or turbine groups;
- 0.2 raptors/turbine/year (all raptors) across a wind power project;
- 0.1 raptors/turbine/year (raptors of provincial conservation concern) across a wind power project; or
- 2 raptors/wind power project (<10 turbines)

Studies indicate that turbine-related mortality maintained below these thresholds is unlikely to affect bird populations. Thresholds have been established based on the highest reported bird mortality at wind power projects in North America, outside California. Post-construction mortality reports from wind power projects in Ontario have shown that approximately two birds per year are killed by individual wind turbines.

A significant bird mortality event is defined by this Guideline to have occurred when bird mortality during a single mortality monitoring survey exceeds:

- 10 or more birds at any one turbine; or
- 33 or more birds (including raptors) at multiple turbines.

The distribution and species composition (e.g. provincial conservation concern species) of bird fatalities should be considered when developing contingency plans. MNR's Natural Heritage Information Centre (Appendix E) is a useful source for identifying and considering birds of provincial conservation concern.

These thresholds are not intended to replace any species-specific approaches that may be needed to comply with the *Endangered Species Act*.

4.2 Post-Construction Monitoring

Post-construction monitoring is required for all Class 3 and 4 wind power projects, as part of the Environmental Effects Monitoring Plan. Post-construction monitoring methods are set out in Appendix B.

Post-construction monitoring will consist of:

- regular bird mortality surveys around specific wind turbines;
- monitoring of bird carcass removal rate by scavengers (or other means);
- monitoring of searcher efficiency (i.e. number of bird fatalities present that are actually detected by surveyors);
- percent area searched;
- disturbance effects monitoring (where a project is located within 120m of bird SWH); and
- subsequent two years of scoped mortality and effects monitoring at individual turbines (and unmonitored turbines in near proximity), following any given year where an annual post-construction mortality reports identifies significant bird or raptor mortality
- Three years of effectiveness monitoring where mitigation applied

Post-construction bird mortality surveys may identify specific species, specific periods of high bird mortality, or specific turbines/ turbine groups linked to bird mortality. This knowledge can be used to identify and scope subsequent monitoring needs, evaluate the success of mitigation measures (i.e. siting), establish protocols for operational mitigation and inform adaptive management.

Searcher efficiency and carcass removal by scavengers is highly variable among sites (varying by vegetation cover, terrain and season) and must be considered when estimating total bird mortality.

In Ontario, the post-construction monitoring season for birds is based on bird activity patterns, covering spring activity through fall migration; thus monitoring occurs from May 1 to October 31 for all birds and continues until November 30 specifically for raptor monitoring.

Monitoring Effort and Timing Requirements

Table 1 identifies the minimum requirements for post construction monitoring.

Table 1.

Minimum Requirements for Post-construction Monitoring Effort and Timing
➢ Post-construction monitoring (including mortality surveys, carcass removal and searcher efficiency trials) should be conducted during the core season when birds are active (i.e. May 1st – Oct. 31st) for the first three years of wind turbine operation.
➢ Mortality surveys should be conducted at each monitored turbine twice per week (3 and 4 day intervals) from May 1st – October 31st and raptor mortality surveys should be continued once per week from November 1st – November 30th.
➢ Bird mortality surveys should occur at all turbines at wind power projects ≤ 10 turbines. For wind power projects >10 turbines, a sub-sample of at least 30% of turbines (minimum 10 turbines) should be selected to cover representative areas throughout the project location.
➢ All turbines within the project location should be monitored once a month during the survey period for evidence of raptor mortalities.
➢ Subsequent post-construction mortality and effects monitoring should be conducted for two years at individual turbines (and unmonitored turbines in near proximity) where significant bird

or raptor annual mortality is identified.

- Effectiveness monitoring at individual turbines should be conducted for three years where mitigation has been implemented.

Post-construction mortality monitoring should begin upon the commencement of operation of the wind power project, when the majority (>50%) of turbines are operational. If the project is constructed in phases, mortality monitoring for each phase should coincide with the commencement of operation of that phase. Monitoring for the final phase of development should be conducted in conjunction with all phases in operation so that potential effects of the entire wind power project can be assessed. When available, post-construction monitoring data may be useful in considering potential effects to bird and bird habitat in adjacent phases.

Post-Construction Monitoring reports should be submitted to the Ministry of Environment for each monitoring year as part of the Environmental Effects Monitoring Plan.

4.3 Post-Construction Mitigation

Post-construction mitigation, including operational mitigation and contingency plans are to be identified in the Environmental Effects Monitoring Plan. Post-construction mitigation may be required at individual turbines or groups of turbines where post construction monitoring identifies significant annual bird or raptor mortality, disturbance effects associated with bird SWH, or significant bird mortality events.

For turbines located outside 120 metres of bird SWH, two years of subsequent mortality and effects monitoring is required where a significant annual bird or raptor mortality threshold is exceeded. Based on the results of subsequent mortality and effects monitoring, post-construction mitigation (e.g. operational mitigation) and effectiveness monitoring may be required at individual turbines where a mortality effect has been identified or significant annual mortality persists.

For turbines located within 120 metres of bird SWH, immediate post-construction mitigation (including operational mitigation) and three years of effectiveness monitoring may be required where monitoring identifies significant annual bird or raptor mortality or disturbance effects associated with bird SWH.

Operational mitigation techniques may include periodic shut-down of select turbines and/ or blade feathering at specific times of the year when mortality risks to the affected bird species is particularly high (e.g. migration).

A contingency plan addresses immediate mitigation actions necessary in case of a significant bird mortality event. A contingency plan allows mitigation measures to be implemented in the event that unanticipated negative environmental effects are observed during a single mortality monitoring survey.

Post construction mitigation considerations for wind power developments are outlined the *Significant Wildlife Habitat Technical Guide* and in the Environment Canada guidance document, '*Wind turbines and birds: a guidance document for environmental assessment'* (EC-CWS, 2007b).

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Appendix A: Best Management Practices

This Guide encourages wind power developments to adopt the best management practices outlined below.

- The Canadian Wind Energy Association, Canadian Wildlife Service, Bird Studies Canada and MNR have established a database for bird and bat data associated with wind power projects. Applicants are encouraged to submit pre and post-construction data to the Wind Energy Bird and Bat Monitoring Database to facilitate an improved understanding of the effects of wind turbines on birds, allow for greater consistency in assessment of wind power effects and lead to future improvements in approval processes. The database allows individual industry applicants and/or their consultants to enter bird survey data in a confidential environment. The data can then be analyzed to determine trends, inform guidance, develop best management practices and effective mitigation options as well as provide provincial data summaries for the public.

- Appropriate project location appears to be the key factor in preventing negative effects on birds. Landscape features in the area (especially ridges, steep slopes, valleys and landforms such as peninsulas and shorelines that funnel bird movement) may increase the risk associated with avian mortality at a wind power development.

- Mortality surveys that incorporate the use of trained dogs (i.e. dog-handler teams to locate mortalities) improve searcher efficiency, and should be considered, particularly in difficult terrain.

- Post-construction monitoring (including mortality surveys, carcass removal trials, and searcher efficiency trials) may be combined with the required post-construction bat mortality studies provided the considerations described in this Guideline are given to birds. See Appendix D for further details pertaining to bird mortality studies.

- Emerging and new technologies should be considered that may reduce bird fatalities. Recent studies suggest that avian fatalities can be reduced by replacing non-flashing/steady-burning red lights with red strobes, white strobes, and red, incandescent, flashing lights.

Appendix B: Methods for Evaluating Bird Significant Wildlife Habitat

The following methods are sourced from *'Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds'* (EC-CWS, 2007c) and applicable methods should be used in conjunction with criteria from the *Significant Wildlife Habitat Technical Guide* for identifying candidate and confirmed bird SWH and defining an area that supports the form and function of bird SWH.

Details of selected sampling protocols

This Appendix provides further details on some of the sampling protocols that are likely to be appropriate for bird monitoring in the context of wind energy.

Note that, whichever sampling methods are used, a complete written field protocol describing the exact sampling methods should be provided as part of the documentation and reporting. This documentation should include precise coordinates of all locations surveyed (preferably from GPS).

Area searches

- Area searches are intensive searches with the goal of finding as many bird species as possible present in an area and providing very general information on bird abundance and status.
- Area searches must be undertaken by a qualified biologist or contractor skilled at recognition by song (during the breeding season) and by sight (at all times of year) of all bird species likely to occur in an area.
- The minimum searching effort for obtaining a list of breeding species in an area would normally be a few hours for a small wind energy installation, ten or more hours for a medium wind energy installation or twenty or more for a large wind power project (for details on what constitutes a small, medium, etc., wind energy installation see Environment Canada's Wind Turbines and Birds: a Guidance Document for Environmental Assessment). For very large wind energy installations, bird range maps or breeding bird atlas data combined with habitat information, can be used to determine the number of species that might be expected in the area. Searching should continue for at least 20 hours, or until at least 80% of the expected number of species have been found (on the assumption that remaining species are probably present in very low numbers).
- For breeding season studies in areas with a variety of natural habitats, multiple visits increase the chances of detecting species that breed early or late in the season. Searches can be made more efficient by concentrating at times of peak bird activity (early morning for most songbirds, late morning or early afternoon for soaring raptors, early evening for owls and other crepuscular/nocturnal species).

- The procedure is to search through all the main habitat types in the area and record all birds seen and heard and to estimate the number of individuals detected on each visit. In addition, for breeding season studies, any evidence of breeding should be recorded.
- Data recorded should include:
    - The level of effort for each visit (date, start time, finish time, hours of searching, weather conditions during the survey and some measure of the area searched, such as the distance covered, or a map of the area that was searched).
    - A complete list of species detected on each visit/each day.
    - For breeding season surveys, data on any breeding evidence detected, using standard breeding bird atlas codes (EC-CWS, 2007c).
    - A basic description of the habitats covered.
    - These data should be retained for entry into the database.
    - In addition, summary data should be calculated that indicate all species detected at each season, with estimates of peak numbers, and total sampling effort.
    - A GPS track log or shape file representing area searched.

Standardized area searches

- Standardized area searches are a quantitative variation on an area search in which the area being searched and the search effort are strictly standardized and the number of individuals of each species detected during the sampling period is recorded to provide an index of abundance.
- For recording songbirds during the breeding season, especially in forested habitats, these are harder to standardize than point counts. However, they may be the best available option for counts outside the breeding season, for sampling species that are not readily detected by song, or when surveying sites that are too small to fit more than a few point counts.
- Usually these involve sampling only a portion of the study area, unless the study area or the particular habitats of concern (e.g., wetlands or tidal mudflats) can all be sampled on a single survey session. One variation on standardized area searches is a fixed width transect, in which a route (transect) is selected, and all birds within a fixed distance of the transect are recorded. The appropriate transect width depends on habitat and species of interest: for songbirds in heavily vegetated areas, few birds are detected more than 100 m away; for raptors or waterbirds in open areas, birds may be detected and identified at distances of 1 km or more with good optical equipment. Square, circular or rectangular plots up to 1 km2 have also been used in various circumstances; the area(s) to be surveyed can be any shape, provided that the shape is clearly documented, the effort is standardized, and the same areas are surveyed on each occasion.
- Data recorded should be the same as for other area searches (see above).

Line transects (distance sampling)

- A line transect is a form of distance sampling which, if assumptions are met, can be used to provide density estimates.
- The most important assumptions are that transects are placed randomly with respect to habitat, that distance between the transect line and the bird can be accurately estimated (e.g. using a laser range finder), that all birds very close to the transect are detected, that the birds do not move before being detected, and that they are not counted more than once.
- Random placement of transects is usually only possible in fairly uniform areas. In terrestrial habitats, this is most likely to be possible in grasslands or low shrub areas, but can also sometimes be done in forested areas.
- Line transect sampling can be a particularly useful technique for shipboard surveys in marine environments (but distance sampling methods can not be used to estimate density for water bird surveys conducted from a beach or shoreline, because the distribution of birds with respect to the coast is usually not random).
- Transects may be any length that can be conveniently surveyed within the optimal survey times (which would be early morning for songbirds, but may be more flexible for marine birds).
- This method involves travelling along the transect at a fairly uniform speed, and recording the shortest (perpendicular) distance from the transect to the position where each bird was first

detected (note that this would normally be less than the distance between the observer and the bird).

- Data can be grouped into distance categories (e.g., 25 m distance bands), but if possible, it is preferable to estimate actual distances. If necessary, these can always be grouped during data analysis. If birds are present in flocks or groups, then the distance to the centre of each flock should be recorded, along with the estimated number of birds in the flock.
- The position of birds along the transect should be recorded as well, usually by dividing the transect into segments, and recording which segment each bird was observed. Segments could be from 100–500 m long depending on the total transect length and range of habitats traversed.
- Data recorded for each transect survey should include:
    - Start location and ending location for each segment on the transect as well as the whole transect (or details, preferably in the form of a Geographic Information System (GIS) shape file, of the complete path of the transect if it is not a straight line).
    - Date, start time, and end time for each individual survey.
    - Individual records for each bird (or flock) with its distance from the transect, segment number, and flock size.
    - Alternatively, records can be kept of the total number of birds of each species in each distance band for each segment along the transect.
    - Weather conditions

Behavioural studies (watch counts)

- These may be required when species at risk, raptor concentrations, or flocks of other birds are present in or around a project location, to determine whether their behaviour might lead to a significant risk of mortality from wind energy installations.
- Behavioural studies are intended primarily to determine how birds are using the area, especially to determine whether they are regularly flying through areas that will be swept by blades after the turbines are built, or are using project locations or habitats that will be directly affected by the construction process.
- The optimal protocols depend on the species being observed as well as the topography of the project location; a customized design will be required in most cases. This design should be developed by the contractor and submitted to MNR for review before implementation. A typical study might involve finding a suitable vantage point from which birds can be observed and recording the movements of birds and the major habitats that they are using at different times throughout the day.
- Observations should only be undertaken at the appropriate season, on days when significant numbers of the species of interest are present in the area, and should typically be undertaken on multiple days to assess day-to-day variation in activity.
- Data recorded will depend on details of the sampling protocol but, as a minimum, should include information on dates and times when surveys were undertaken, as well as summary statistics on how often birds, and how many birds flew through potential turbine locations, whether they were flying within, above or below the blade height of turbines to be installed, and how often they used project locations that would be disturbed by construction.

Point counts

- To be effective, point counts must be placed at well-chosen locations, carried out by experienced observers (unless microphones are being used to record them – see next section) and performed at the appropriate time of day in appropriate weather conditions.
- Point Count Placement:
    - Point count locations may be chosen either randomly or systematically (e.g., at regular intervals along a route) within the target habitats. If they are placed systematically, then the starting point of the route should be randomly chosen, if possible. Point count locations should be chosen to emphasize areas near prospective turbine project locations as much as possible. Point counts should generally not be placed on roadsides, but it is acceptable to select a starting point for a route along an access road.

- If the area consists of relatively large areas of homogeneous habitat, then point counts should be placed within each major habitat type, ideally with the centre point at least 100 m from the habitat edge.
- If the project area consists of a fragmented mosaic of habitats (e.g., small fields interspersed with hedgerows and small woodlots) such that it would be hard to place many points >100 m from a habitat edge, it may be more effective to consider the whole landscape as one "habitat" and place point counts randomly or systematically within it.
- Every major habitat type within the project area (pine forest, hardwood forest, scrub, grassland, field, etc.) likely to support significant numbers of breeding birds should be included.
- At least 20 stations are normally required to sample a habitat adequately, spaced at least 250 m apart in forest, or 500 m apart in open habitat. These stations may be distributed among several different blocks of habitat.
- The number of stations per habitat can be reduced if the total area of a particular habitat within the project location is too small to support 20 stations– contact MNR for guidance on sample size.
- Once station locations have been selected, they can be grouped into routes in a way that allows for maximum efficiency of visits – it is not necessary to visit all stations for a particular habitat type on the same day.
- Post-construction monitoring seeks to assess the impact of turbines on bird abundance and distribution.
    - Two alternative designs for point count placement can be considered:
        - One approach is to survey the exact same locations as were surveyed during pre-construction. This approach gives information on the overall, landscape-level impact of the turbines, but less information on the specific impact of the turbines.
        - Another approach is to select new point count locations in relation to the turbines (e.g., points 100, 300, 400m away from turbines). The number of points and number of turbines sampled would depend on their configuration and on the diversity of habitats in which they are located. Stations should be selected so that some are downwind of turbines, based on prevailing wind direction, while others are upwind, as the noise impacts, and hence disturbance effects on birds may differ.
    - An ideal design would incorporate both approaches, by selecting pre-construction point count locations in relation to proposed project locations based on the above design. However, this may not always be possible for various reasons, including uncertainty at the time of the initial surveys in the eventual location of the turbines.
    - The appropriate design for a particular project location should be determined in consultation with MNR.
    - The extent and intensity of monitoring expected will depend on the species richness and densities present in the project location pre-construction surveys.
- Each station must be georeferenced by GPS.
- The habitat within 100 m of the station should be described in qualitative terms, unless a complete habitat map for the area has been prepared and the points can be placed on that habitat map. The habitat description should incorporate summary information on habitat structure (e.g., forest, marsh, field), dominant vegetation types within the habitat (e.g., major tree species), and, for forest or shrub habitats, an estimate of stand age and average stand height.
- The habitat coding system used by the Ontario Nest Records Scheme is recommended for coding the major structural habitat types in most parts of Canada.

- Point count timing and survey conditions:
    - Point counts must be performed in the early morning during the breeding season, between dawn (one half hour before sunrise) and about 4 hours after sunrise. Later in the season, singing drops off more quickly – surveys in late June and early July should usually be completed within 3 hours of sunrise.

  - The peak breeding season varies geographically, but in most parts of Canada it extends from late May to early July. Consult the MNR for the optimal dates for a particular region.
  - Each station should be surveyed a minimum of three times, conducted early in the season, mid season and later in the season (at least 10 days between surveys at a particular station).
  - Point counts should be performed when there is as little wind as possible, because wind affects the observer's ability to hear birds. Usually, this means that wind speeds should be 3 or less on the Beaufort scale.
  - It is important to always begin point counts as early as possible in the morning (but not earlier than one half-hour before local sunrise), when the wind is generally calm so that windy conditions that may arise later in the morning can be avoided.
  - Point counts should not be conducted if it is raining unless precipitation is not more than a light drizzle (birds tend to stop singing in the rain).
  - During post-construction point counts, in some areas, the sound of the turbines may affect the ability to hear birds. If this is a problem, it may be necessary to stop turbines near the point location while the point count is being undertaken; if wind conditions are low enough for point counts, then energy production from the turbine is likely to be minimal at that time anyway. Failure to control turbine noise during post-construction surveys may lead to under-detection of birds and over-emphasis of the impact of turbines on bird communities.
  - If turbine noise is a problem and can not be adequately controlled, then MNR should be consulted to determine whether an alternative point placement design may be feasible.
- Data recording:
  - At each station, the surveyor should listen for ten minutes, recording all species seen or heard, along with an estimate of the number of individuals of each species.
  - The surveyor should estimate the distance to each bird using a scale of 0–50 m, 50–100 m and further than 100 m. Birds that move during the survey should be recorded in the closest distance category that they entered during the survey. Distances can often be difficult to judge when a bird is only heard singing in dense habitats, in which case the observer should provide a best estimate. This will still be valuable for differentiating birds that are close from those that are very distant.
  - Data that need to be reported are the number of birds of each species detected in each distance band. It is often easiest to track individual birds if they are first mapped onto a circular diagram using a standard set of symbols, and then the number of individuals counted up afterwards.
  - Birds that fly over without stopping should be recorded separately as "fly-overs".
  - Additional information that should be recorded include:
    - Weather conditions (temperature, wind speed (on a Beaufort scale), % cloud cover, and presence of any precipitation should be recorded).
    - Date and time of day.
    - GPS coordinates of the point location.
    - Name of the observer doing field work.
    - A data form (EC-CWS, 2007c) may be used, but is not necessary provided that all of the relevant data are recorded. Use of some sort of data form is desirable to ensure that all required data are recorded in the appropriate format, thus facilitating later computer data entry.

Playback counts

- Playback of recordings is used primarily to detect secretive species, such as owls or marsh birds, or to obtain more information on particular species, such as species at risk, where the presence of even a few individuals of a species may be of concern.
- In many cases, it is sufficient to do this qualitatively, to detect the presence of particular species, through integration into an area search protocol.
- Quantitative surveys may be expected in some areas, such as if an area contains extensive wetlands that might contain significant numbers of marsh birds. Nationally standardized protocols

for marsh bird monitoring, using playback, are currently being developed. A number of regionally appropriate standard protocols exist for nocturnal owls.

- If a species at risk is expected in an area, the most appropriate protocols should be discussed with MNR before initiating surveys. Quantitative playback surveys for a species at risk may be required if the area is known to contain significant habitat for the species – these would need to be designed in conjunction with an MNR biologist and/or the appropriate recovery team for the species.
- Playback counts involve:
    - Playback of recordings of territorial songs or calls of target species (alarm calls are not appropriate) that are of particular concern and may be expected in the habitat. Each playback should be followed by a period of silent listening to detect responses. Multiple recordings may be played (either repeats of the same species, or different species), followed by silent listening.
    - Playback must be done at the appropriate time of day:
        - Early morning for most songbirds.
        - Early morning or evening for marsh birds.
        - After dark for most owls.
    - Playback should also be done at the appropriate time of year, depending on the species and region. The peak calling period for many owls can be one to two months earlier than the main breeding season for songbirds. Marsh birds tend to be most vocal early in the breeding season.
    - Playback can be attempted in any patches of habitat suitable for the target species. The appropriate spacing will depend on the distribution of habitats. For habitats that are difficult to enter (e.g., wetlands), it is usually acceptable to use playback from the edge of the habitat.
    - Unless following a protocol that has been previously approved specifically for a quantitative survey, playback of calls for a species at risk should be stopped as soon as the species presence has been confirmed, to minimize disturbance to the species.

Stopover counts

- The purpose of stopover counts is to estimate the abundance of birds using the project area as a stopover site on migration, whether for resting or for foraging. The optimal design of a stopover count will depend on the nature of the habitats in the area, and the types of species that might be expected.
- The usual sampling method will be a variation on the standardized area search methods.
- For large open area birds (waterfowl, shorebirds, other waterbirds, etc.), a route should be developed that provides a vantage point over all of the major habitat areas where birds might be expected.
    - In a large project area, this may involve a route of several kilometres, with driving in between observation sites.
    - The objective of this survey should be to estimate the total number of individuals of each species present in the area on a particular visit.
    - If the study area consists of several discrete patches of important habitat, then the number of individual birds of each species on each site should be recorded separately. This information may be important for turbine placement.
    - Data recorded for these surveys should include a map of the route and the major observation sites, the date, the start and end time of each visit.
    - Most waterbirds can be counted at any time during the day. However, in some areas birds may make daily movements from a roost site in one area to a foraging site in another area. Similarly, in tidal areas, birds may move among locations in response to tidal cycles. In these cases, counts should be timed to coincide with peak numbers present within the study area.
    - If significant numbers of birds are located, then behavioural studies (see relevant section) should be considered to determine whether the behaviour of these birds is likely to put them at risk from the wind turbines.

- For songbirds, routes should be selected that sample the major habitats likely to be used by songbirds in the region.
    - Routes can be placed along existing trails or roads. Foraging migrants are most readily detected at edges of habitats, in hedgerows, etc.
    - A good quantitative design is to set out transects approximately 500 m long along trails or roads, placing at least two per major habitat type (e.g., forests, shrubland, grassland, etc.). Individual transects may traverse multiple habitats. However, transects can be any length, provided that the same routes are visited each time.
    - Transects should be walked approximately twice a week in the early morning (sunrise to up to no more than 4 hours after sunrise) during the peak migration period for the species of interest.
    - In most cases, it is sufficient to record the total number of birds of each species detected along the transect, using standardized area search methodology.
    - In some habitats, it may be appropriate to use line transect methodology and record the distance to each bird, or the number of birds in fixed distance categories (e.g., 25 m distance bands), separately counting different segments of the transect.

Diurnal passage migration counts

- Passage migration counts are used to estimate the numbers of birds flying through an area during migration periods.
- For most songbirds, the spring migration period runs from early April to late May, the fall period from the end of August to the middle of October, although this varies by region, latitude and altitude. Migration of waterfowl may commence in March, while migration of eagles and some northern migrants extends into November.
- For raptors and other diurnal migrating birds the following protocol is recommended:
    - Select an observation point from which a clear view is available of one or more potential turbine locations in areas that may represent migration concentration sites (e.g., ridge tops).
- Record the species and heights of all passing birds in relation to the height of the proposed turbines. Codes can be used for incompletely identified species (e.g., Accipiter sp.).
    - Start at about 9 a.m. and record continuously for 6 hours, dividing the observations into one hour blocks. This will make the data comparable to most raptor monitoring stations.
    - If daily observations are not possible, then observations should be carried out for at least 10 days spread over the peak migration period for species thought to be at risk (consult local naturalists for this information). Within this period, dates should be chosen with weather conditions favourable for migration (e.g., no precipitation, light to moderate tail winds).
    - Record weather conditions (temperature, wind speed and direction, sky cover, precipitation), date, time of day, GPS coordinates of the observation point, and the approximate area and direction over which most observations were made.
- For night-migrating birds or bats, passage migration counts require technological approaches including either radar or acoustic monitoring or both. These are described in further detail in subsequent sections.

Acoustic monitoring of migrating birds

- Many species of songbirds regularly make flight calls during nocturnal migration; many calls can be identified to species. Microphones and digital recorders can be used to monitor these species during migration. However, not all species call during migration, and little is known about how often individual birds call and how much this varies from night to night or with weather conditions. To get a more complete picture of the number of birds migrating through another area, acoustic monitoring may need to be combined with other techniques such as radar, infrared video devices, or observations with a ceilometer (a laser beam continuously projected toward the sky to measure cloud cover). Nevertheless, acoustic monitoring alone may sometimes be sufficient for understanding regional variation in the concentrations of migrating birds or the heights of birds.

- A variety of systems have been used for monitoring nocturnal migrants ranging from single microphones connected to a digital recorder that provide an index of bird activity, to arrays of 4 or more microphones connected to a computer that can be used to calculate the height and position of each bird's call.
- Note that acoustic systems used for monitoring birds are not suitable for monitoring bats, because of the difference in frequency range of their calls.
- In general, systems that monitor height are likely to be more relevant to wind energy installation monitoring than systems that only provide an index of total numbers.
- National standards have not yet been developed for acoustic monitoring. At present this technique is most likely to be required only in the context of a research project. If nocturnal flight call monitoring is required for a particular project, then a protocol should be worked out in conjunction with MNR.

Radar monitoring

- Marine radar units can be used to monitor activity of birds and bats within a relatively large area (a few kilometres radius) from a single location.
- However, radar has the disadvantage that targets can rarely be positively identified to species. Methods for distinguishing birds from bats, based on flight patterns, are being developed, but have not been fully tested.
- A variety of systems have been developed for automated data collection and processing. This is particularly important for monitoring over longer time periods, such as a complete migration season. However, most of these automated systems are relatively expensive, and only a few consulting companies have expertise with this technology. Each company uses different approaches for automated processing of data and estimating trajectories and/or heights of flying birds and bats. Most of these approaches have not yet been compared and cross-validated; it is not yet possible to recommend one system over another.
- As such, radar is not generally required for monitoring unless there are particular risk factors involved, such as a suspected migration corridor for bats or birds or concerns about particular species at risk.
- If radar is selected, the ideal sampling scheme would involve monitoring on a daily basis through the main migration period for species of concern, especially if a fully automated system can be deployed.
- If this is not possible, because of limited availability of technology or other logistic constraints, then less intensive sampling may be acceptable. Various sampling schemes can be considered, depending on logistical constraints such as the remoteness of the site and the availability of radar. If daily coverage is not possible, the next most preferred option would involve monitoring at regular intervals throughout the season (e.g., one or two nights per week, preferably concentrated on nights when weather conditions are favourable for migration—tail winds that are not too strong, no precipitation). Another option would involve sampling for a few days in a row at longer intervals, e.g., for 2-3 days every two weeks. If data are available on the likely peak migration period for species of concern, then continuous monitoring for 1 or 2 weeks during this period may also be acceptable.
- Regardless of the sampling scheme, monitoring should continue through the night, either recording continuously (preferred) or for periodic intervals such as 15-30 minutes per hour.
- Data that are recorded should include:
    - Technical information on the equipment used, including information on maximum range, minimum and maximum altitude at which targets can be detected at various distances, methods used for data analysis, etc.
    - For each biological target detected, data should include information on its identity to the extent possible (e.g., bird vs. bat), its trajectory (including direction of travel and position in relation to potential turbine project locations), and altitude (if known).
    - Data can then be summarized in various ways to indicate overall bird and bat activity, how this changes over the night and the season, and how it varies across the study area.

  - Summary data should be provided as part of the Environmental Impact Assessment. Raw data (i.e., information on individual tracks) should be retained for inclusion in a central database, once appropriate data standards have been developed.
- As with acoustic monitoring, the uncertainty in protocols is such that this technique is most likely to be required only in the context of a research project. If radar monitoring is required for a particular project, then the most suitable protocol should be worked out in conjunction with MNR.

Appendix C: Post Construction Monitoring Methods

Bird Mortality Survey

Bird mortality surveys identify the number of birds that are killed per turbine over a known period of time (expressed as birds/turbine/time). Due to the differences in sizes of turbines, it is also important that the bird mortality be expressed in birds/MW/time. This value represents a minimum estimate of bird mortality adjusted for bird carcass removal rates, searcher efficiency, and percent area searched. Standard guidelines for bird mortality surveys are identified below.

Applicants are required to obtain a 'Wildlife Scientific Collectors Authorization' from MNR for all bird mortality surveys. Bird mortality surveys should consider the following:

- Post-construction monitoring designs are reviewed by MNR as part of the renewable energy approval process and prior to commencing turbine construction.
- The sub-sample of wind turbines that are monitored should cover all habitat types present at the project location and the spatial distribution of the wind turbines. The specific number of turbines searched may vary from site to site based on the size of the project (e.g., more turbines will be searched at larger wind power projects to achieve a reasonable level of search confidence). Wind turbines should be selected through a scientifically defensible system (e.g., stratification).
- The time required to search each turbine will vary depending on the surrounding habitat (e.g. open field vs. forest, etc.).
- Where possible, each turbine will have a 50m search radius and the complete area will be searched. It is recommended that those turbines that would not be searchable due to vegetation cover or other impediments should not be included in the sub-sample.
- Where possible, ground cover around turbines should be maintained at a low level in order to facilitate more accurate bird mortality surveys.
- The search area of each turbine will be mapped into visibility classes according to the following table:

% Vegetation Cover	Vegetation Height	Visibility Class
≥90% bare ground	≤ 15cm tall	Class 1 (Easy)
≥ 25% bare ground	≤ 15cm tall	Class 2 (Moderate)
≤ 25% bare ground	≤ 25% > 30cm tall	Class 3 (Difficult)
Little or no bare ground	≥ 25% > 30cm tall	Class 4 (Very difficult)

- The search area is examined using transects 5.0 – 6.0 metres apart allowing for a visual search of 2.5 – 3.0 metres on each side. The search area may be rectangular, square or circular depending on turbine locations and arrangements and surrounding terrain.
- Only trained and tested searchers should perform mortality surveys.
- It is recommended that surveys incorporate the use of trained dogs (i.e. dog-handler teams to locate mortalities), given the challenges of searcher efficiencies for bird mortalities. Additional survey requirements (e.g. increased trials, longer search times, etc.) may be necessary in complex habitats where bird mortalities are likely to be undetected by searchers (e.g. mortalities caught/lost in dense forest canopy, wetland areas, etc.).
- All carcasses found should be photographed and recorded/labelled with species, sex, date, time, location, carcass condition, searcher, injuries, distance and direction to nearest turbine, ground cover/substrate, estimated number of days since time of death and distance to plot centre. A data sheet sample should be provided in the mortality report.
- The condition of each carcass collected should be recorded in one of the following categories:
    - Intact – a carcass that is not badly decomposed and shows no sign of having been fed upon by a predator or scavenger, although it may show signs of traumatic injury such as amputation from a turbine collision,

  - Scavenged – an entire carcass that shows signs of having been fed upon by a predator or scavenger or a partial carcass that has been fed upon, with portions of it (for example, wings, skeletal remains, legs, feathers) found in more than one location
- Each carcass should be collected (using vinyl, latex or rubber gloves), bagged and stored in a freezer for future reference, identification, and/or necropsy. A copy of the data sheet should be kept with the carcass at all times.
- Carcasses found during bird mortality searches may be used in carcass removal or searcher efficiency trials.

Raptor Mortality Surveys

- In addition to bird mortality survey monitoring, raptor mortality surveys should be conducted once a month at all turbines within the project location during the survey period.
- These additional surveys are not to be added to the sample survey mortality estimate calculations; the purpose of the raptor mortality surveys is to identify any individual or groups of turbines that may exceed the significant mortality threshold.
- Searcher efficiency and scavenger removal trials are only necessary for raptors considered as part of bird mortality survey monitoring, but are not necessary when conducting raptor mortality surveys.
- For the months of October and November, only weekly raptor mortality surveys are necessary at the sampled turbines in addition to the monthly surveys of the remaining turbines.

Carcass Removal Trials

Levels of carcass scavenging should be determined through carcass removal trials. In these trials, carcasses are planted around the wind turbines and monitored until they disappear. The average carcass removal time is a factor in determining the estimated total bird mortality. Carcass removal rates vary considerably from one site to another and seasonally and should be conducted at every wind power project.

Below are some important considerations for conducting carcass removal rate trials:

- Carcass removal trials should be conducted at least once a month (twice each season) during the same period as the bird mortality surveys
- Carcasses should be distributed at all turbines where searches are undertaken, with no more than one or two carcasses per turbine.
- Weather conditions are important factors in carcass removal rates and trials should be conducted in a variety of weather conditions and recorded as such.
- Carcasses should be distributed across the range of different substrates/habitats being searched.
- Carcasses should be placed before daylight using gloves to avoid imparting human smell that might bias trial results (i.e. attract scavengers, etc.).
- Trials should continue until all the carcasses are removed or have sufficiently decomposed.
- To avoid confusion with turbine-related fatalities, trial carcasses should be discreetly marked (e.g. clipping of ear, wing leg, fur or hole punching ear) with a unique identification, so they can be identified as a study carcass.
- Carcasses used should be as fresh as possible since frozen carcasses are less attractive to scavengers. If frozen carcasses are used, they should be thawed prior to beginning carcass removal trials.
- Bird carcasses (including at least one raptor) should be used for some carcass removal trials.
- Scavenger trials should be repeated annually, as the numbers and efficiency of scavengers, especially vertebrates such as raccoons, foxes, crows, etc., may change among years.
- Scavenging rates may change over time as scavengers become aware of and develop search images for new sources of food beneath turbines.
- Scavenging should be determined on a site-specific basis, and it should not be assumed to

be similar between sites in close proximity or in similar habitat conditions in different years.

Searcher Efficiency Trials

Searcher efficiency trials require a known number of discreetly marked carcasses to be planted around a wind turbine. Searchers examine the wind turbine area, and the number of carcasses that they find is compared to the number of carcasses planted. Searcher efficiency is another important factor in creating an estimate of total bird mortality. Searcher efficiency will vary considerably for each searcher and from one site to another, and should be conducted as part of post-construction monitoring at all project locations.

Below are some important considerations for conducting searcher efficiency trials:

- Searcher efficiency trials should be conducted at least once a season during the same period as the bird mortality surveys (described in Table 3). More trials should be conducted if vegetation changes during the season (i.e. crops grow, harvest).
- A minimum of 10 carcasses per searcher per visibility class are to be used. These trial carcasses can be spread out over the trial period and conducted with the bird mortality surveys.
- Searcher efficiency trials are to be conducted for each individual searcher. The searcher should not be notified when they are participating in an efficiency trial to avoid potential search biases.
- Trial carcasses should be discreetly marked (e.g., clipping of ear, wing leg, fur or hole punching ear) with a unique identification so that they can be identified as a trial carcass.
- Trial carcasses should be randomly placed within the search area and location recorded so that they can be retrieved if they are not found during the trial.
- Bird carcasses (including at least one raptor) should be used for some searcher efficiency trials.
- If frozen carcasses are used, they should be thawed prior to beginning searcher efficiency trials.
- Searcher efficiency trials should be repeated annually.

Percent Area Searched

Based on post-construction data gathered to date in Ontario, most birds appear to fall within 50m of a wind turbine base, therefore this area represents the maximum recommended search area. Since it may not always be possible to search the entire 50m radius (because of the presence of thick or tall vegetation, steep slopes, active cultivation, etc.), the actual area searched during the mortality surveys should be calculated at each turbine, using a GPS. Provide a description of areas deemed to be unsearchable (e.g. vegetation height, type, slope, etc). A map of the actual search area for each turbine searched should be provided in the mortality report.

In cases in which all of the 50m radius cannot be searched, it is recommended that the density of distribution of carcasses be calculated as part of the overall estimated mortality. This is due to studies showing there to be a distribution curve for the distance of carcasses from the turbine base with a larger percentage of carcasses falling closer to the base and that number decreasing with increased distance from the base of the turbine.

Calculations

Scavenger Correction Factor

Proportions of carcasses remaining after each search interval are pooled to calculate the overall scavenger correction (S_c) factors:

$$S_c = \underline{n_{visit1} + n_{visit2} + n_{visit3}}$$

$n_{visit0} + n_{visit1} + n_{visit2}$

S_c	is the proportion of carcasses not removed by scavengers over the search period
n_{visit0}	is the total number of carcasses placed
$n_{visit1} – n_{visit3}…$	are the numbers of carcasses remaining on visits 1 through 3

Searcher Efficiency

Searcher efficiency (S_e) will be calculated for each searcher as follows:

$$S_e = \frac{\text{number of test carcasses found}}{\text{number of test carcasses placed} – \text{number of carcasses scavenged}}$$

The number of turbines that each individual searches will vary so it will be necessary to calculate a weighted average that reflects the proportion of turbines each searcher searched. The weighted average or overall searcher efficiency will be calculated as follows:

$Se_o = Se_1(n_1/T) + Se_2(n2/T) + Se_3(n_3/T)…$

Se_o	is the overall searcher efficiency
Se_1 and $_2$ and $_3…$	are individual searcher efficiency ratings
N_1 and $_2$ and $_3…$	are number of turbines searched by each searcher
T	is the total number of turbines searched by all searchers

Percent Area Searched

Percent area searched (P_s) is calculated as follows:

$$P_s = \frac{\text{actual area searched}}{\pi r^2}$$

r = 50m

Corrected Mortality Estimates

The minimum estimated bird mortality (C) is calculated as follows:

C = c / (Se x Sc x Ps), where

C	is the corrected number of bird fatalities
c	is the number of carcasses found
S_e	is the proportion of carcasses expected to be found by searchers (searcher efficiency)
S_c	is the proportion of carcasses not removed by scavengers over the search period
P_s	is the percent of the area searched.

Other Notes and Considerations

- The above calculations should be presented in corrected number of birds/turbine/season and birds/MW/season. In this context, the season is the 22 weeks of monitoring.

- Post-construction monitoring (including mortality surveys, carcass removal trials, and searcher efficiency trials) may be combined with the required post-construction bat mortality studies provided the considerations described in this guideline are given to birds. See

Environment Canada's '*Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds'* (EC-CWS, 2007) for further details pertaining to bird mortality studies.

- A separate calculation for raptor mortality should use the searcher efficiency and carcass removal results relevant to raptors.

- Bird carcasses may be discovered incidental to formal searches. These carcasses should be processed (i.e. collected, recorded, etc.), and fatality data should be included with the calculation of fatality rates. If the incidentally discovered carcass is found outside a formal search plot, the data should be reported separately.

- Tissue samples from bird carcasses may be used in a number of DNA analyses to provide insight into population size and structure, as well as the geographic origin migrants. The local MNR office should be contacted prior to disposing bird carcasses, to determine if this type of research is occurring in the area.

Appendix D: Sources of Information for Records Review

The following sources of information may be useful in providing data to assist with Records Review (Section 3.2):

Canadian Wildlife Service (CWS) – Project WILDSPACE™
Fifty years of wildlife surveys and research projects by the CWS in Ontario
Website: http://wildspace.ec.gc.ca

Conservation Ontario
Links to all Conservation Authorities in Ontario. Conservation Authority staff may be aware of important bird information within their respective watersheds.
Website: http://conservation-ontario.on.ca

Land Information Ontario (LIO) – Ontario's Land Information Directory (OLID)
Ontario's land information warehouse; including information on birds, bird habitat and other potentially useful data (e.g., bird banding sites, nesting sites, bird watching sites, etc.).
Website: http://lioapp.lrc.gov.on.ca/edwin/edwin.asp

Nature Conservancy of Canada (NCC)
Includes links to NCC projects.
Website: http://www.natureconservancy.ca

Ontario Ministry of Natural Resources – Natural Heritage Information Centre (NHIC)
Information on wildlife species (particularly rare, threatened and endangered species and spaces) in Ontario. NHIC acts as a provincial database for sensitive information for birds.
Website: http://nhic.mnr.gov.on.ca/nhic.cfm

Ontario Ministry of Natural Resources – Natural Resources & Values Information System (NRVIS)
Warehouse for natural resource data for Ontario.
OMNR Intranet: http://intra.omafra.gov.on.ca/lrccluster/nrvis/index.htm
NRVIS Support: Phone: (705) 755-1650 or Email: nrvis.support@mnr.gov.on.ca

Ontario Ministry of Northern Development, Mines and Forestry (OMNDMF)
Information on mining and geology in Ontario. Also home to the Ontario Geological Survey, which has information on provincial geology and landscapes.
Website: http://www.mndm.gov.on.ca/MNDM/Default.asp

Appendix E: Other Sources of Information on Birds and Wind Power

Bird Observatories (conduct search of local area for observatories)
Haldimand Bird Observatory, Ontario: http://geocities.com/haldimandbirdobservatory/
Prince Edward Point Bird Observatory, Ontario: http://www.peptbo.ca/
Bruce Peninsula Bird Observatory, Ontario: http://www.bpbo.ca/
Toronto Bird Observatory, Ontario: http://www3.sympatico.ca/tboweb/
Long Point Bird Observatory, Ontario: http://www.bsc-eoc.org/longpoint/
Thunder Cape Bird Observatory, Ontario: http://www.bsc-eoc.org/national/tcbo.html
Innis Point Bird Observatory, Ontario: http://homepage.mac.com/ipbo/
Holiday Beach Migration Observatory, Ontario: http://hbmo.org/
Hawk Cliff Raptor Observatory, Ontario: http://www.ezlink.ca/~thebrowns/HawkCliff/index.htm
Niagara Peninsula Hawkwatch, Ontario: http://www.hwcn.org/link/niaghawk/index.html
Whitefish Point Bird Observatory, Michigan: http://www.wpbo.org/
Rouge River Bird Observatory, Michigan: http://www.umd.umich.edu/dept/rouge_river/index.html
Black Swamp Bird Observatory, Ohio: http://www.bsbobird.org/

Braddock Bay Bird Observatory, New York: http://www.bbbo.org/
Derby Hill Bird Observatory, New York: http://www.derbyhill.org/
Cornell Laboratory of Ornithology, New York: http://www.birds.cornell.edu/

Bird Studies Canada
Links to BirdMap Canada (an interactive mapping tool) and various other program areas
Website: http://www.bsc-eoc.org/

Canadian Wildlife Service (CWS) – Project WILDSPACE™
Fifty years of wildlife surveys and research projects by the CWS in Ontario.
Website: http://wildspace.ec.gc.ca
Project Lead: Don McNicol, Canadian Wildlife Service, Telephone: (613) 949-8266

Conservation Ontario
Links to all Conservation Authorities in Ontario
Website: http://conservation-ontario.on.ca

Ducks Unlimited Canada
Links to local offices, information on protected areas, etc.
Website: http://www.ducks.ca/province/on/index.html

Environment Canada – Species at Risk
Information on species at risk, recovery strategies, and recovery team members
Website: http://www.speciesatrisk.gc.ca

Hawk Migration Association of North America
Information on raptor migration throughout North America.
Website: http://hmana.org

Important Bird Areas of Canada
IBA sites in Ontario – information on size, habitat, species, land use, & conservation status
Website: http://www.ibacanada.com

Land Information Ontario (LIO) – Ontario's Land Information Directory (OLID)
Ontario's land information warehouse; including information on birds, bird habitat and other potentially useful data (e.g., bird banding sites, nesting sites, bird watching sites, etc.).
Website: http://lioapp.lrc.gov.on.ca/edwin/edwin.asp

The Nature Conservancy of Canada (NCC)
Includes links to NCC projects
Website: http://www.natureconservancy.ca
Contact Ontario office: ontario@natureconservancy.ca
Toll-free: 1-877-343-3532

North American Bird Conservation Initiative
Website: http://www.bsc-eoc.org/nabci.html

North American Waterfowl Management Plan
Website: http://www.nawmp.ca

Ontario Bird Banding Association
Links to associated bird observatories
Website: http://ontbanding.org/

Ontario Breeding Bird Atlas
Breeding evidence and range maps

Website: http://www.birdsontario.org

Ontario Eastern Habitat Joint Venture (implementing bird conservation projects)
Website: http://www.on.ec.gc.ca/wildlife/ehjv/oehjv-e.html

Ontario Federation of Anglers and Hunters
Website: www.ofah.org

Ontario Ministry of Natural Resources – Natural Resources & Values Information System (NRVIS)
Warehouse for natural resource data pertaining to the Precambrian Shield area.
OMNR Intranet: http://intranet.lrc.gov.on.ca/nrvis/About_NRVIS/NRVIS%20Intro/nrvisIntro.htm
NRVIS Support: Phone: (705) 755-1650 or Email: nrvis.support.mnr@ontario.ca

Ontario Ministry of Natural Resources – Natural Heritage Information Centre (NHIC)
Compiles, maintains and provides information on rare, threatened and endangered species and spaces in Ontario.
Website: http://nhic.mnr.gov.on.ca/nhic.cfm

Ontario Nature
Links to the Ontario Nature Network – 140 community conservation groups across Ontario
Website: http://www.ontarionature.org/

Ontario Nest Records Scheme- Manual recommended for coding the major structural habitat types
Website: http://www.birdsontario.org/onrs/instructions.html

Ontario Shorebird Conservation Plan
Website: http://www.on.ec.gc.ca/wildlife/plans/shorebirdplan-e.html

Partners in Flight (Ontario)
Links to Ontario Land Bird Conservation Plans
Website: http://www.bsc-eoc.org/PIF/PIFOntario.html

Royal Ontario Museum
Website: http://www.rom.on.ca/collections/history.php

UNESCO Biosphere Reserves – Canadian Biosphere Research Network (CBRN)
Links to Ontario Biosphere Reserve sites
Website: http://www.biosphere-research.ca

Upper Mississippi Valley/Great Lakes Waterbird Conservation Plan (incl. part of Ontario)
Website: http://www.pwrc.usgs.gov/nacwcp/umvgl.html