Bats and Bat Habitats: Guidelines for Wind Power Projects

Ministry of Natural Resources
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Ontario

BATS AND BAT HABITATS

Guidelines for Wind Power Projects

Ontario Ministry of Natural Resources

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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 new 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 (MOE) Renewable Energy Approvals Regulation (O.Reg. 359/09), and the Ministry of Natural Resource's (MNR) Approval and Permitting Requirements Document for Renewable Energy Projects.

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

In Ontario and throughout North America, bat populations appear to have declined in recent decades. This decline is thought to be related to habitat alteration and destruction throughout their range and White Nose Syndrome, a condition responsible for the recent mortality of large numbers of bats in the northeastern United States. In March 2010, White Nose Syndrome was identified in Ontario for the first time. Bats are long-lived animals with low reproductive rates, making populations particularly vulnerable to increased mortality. In recent years, bat mortality has been documented at wind power projects in Ontario and throughout North America.

The purpose of this Guideline is to provide guidance on identifying and assessing bat habitat, and addressing potential negative effects on bats and bat habitats during the planning, construction, and operation of onshore wind power projects in Ontario. This Guideline supports the Renewable Energy Approvals Regulation and applies on both Crown and private land.

1.1 Potential Effects of Wind Power Projects on Bats

Bat mortality has been documented at wind power projects in a variety of habitats across North America. In Ontario, annual mortality estimates at wind power projects range from 4 to 14 bat mortalities/turbine/year. Annual bat mortality estimates at wind power projects in North America vary from less than 1 to over 50 bat mortalities/turbine/year.

In recent years, there has been elevated concern about bat mortality at wind power projects because:

- some wind power projects have shown particularly high levels of bat mortality;
- bats can range widely across landscapes and migrate long distances, which may make them more susceptible to cumulative effects;
- post-construction monitoring and research at turbines sites suggest that bats may be more susceptible to wind turbine mortality than birds; and
- potential impacts of White Nose Syndrome make certain species of bats particularly vulnerable to increased mortality.

The Renewable Energy Approvals Regulation and this Guideline focus on consideration and protection of bat SWH when selecting a project location. This approach appears to be a key factor in preventing negative effects on bats and bat habitats. However, knowledge gaps and concerns remain relating to the effect of wind turbines on bats and their habitats.

This Guideline will assist in identifying and addressing concerns associated with bat SWH and interactions between wind turbines and bats, and contribute toward an adaptive management approach to protecting bats and bat habitats.

To this end, the Wind Energy Bird and Bat Monitoring Database for bird and bat data associated with wind power projects has been collaboratively established by MNR, the Canadian Wind Energy Association, Environment Canada - Canadian Wildlife Service, and Bird Studies Canada. The intent of this database is to facilitate an improved understanding of the effects of wind turbines on birds and bats, allow for greater consistency in assessment of wind power effects and lead to future improvements in approval processes.

Wind power projects have the potential to affect bats directly (i.e. collision mortality) and indirectly (i.e. disturbance and avoidance). Direct and indirect effects of potential wind power projects on bats and bat habitats are outlined below.

Direct Effects

Bats may be injured or killed through collisions with moving turbine blades, but do not appear to collide with stationary structures (e.g. turbine towers, transmission structures, guy wires, etc.). Barotrauma (internal haemorrhaging), caused by rapid air pressure reduction near moving turbine blades, has been found to be a source of bat mortality. This undetectable hazard may help explain why bats appear to be more susceptible to wind turbine mortality than birds.

The main factors that appear to contribute to bat mortality at wind power projects are time of year, species, habitat or landscape features in the area, and weather conditions, including wind speed. Bat mortality at wind power sites occurs primarily in the late summer and early fall. Long-distance migratory bats (i.e. hoary bat, eastern red bat, silver-haired bat) typically comprise the majority of bat fatalities. Weather conditions may influence the level of bat activity and consequent mortality at wind power sites. Warm clear nights with low wind have been associated with higher bat activity.

Indirect Effects

Bats may be indirectly affected by wind power projects through effects on habitat and behaviour. Bats may be displaced from suitable habitat due to habitat loss or fragmentation during the construction and/or operation of a project, human activity, or noise (e.g. construction activities, roads, turbines, etc.). Deforestation associated with a project may remove woodland habitat important to breeding or roosting bats. Bat habitats may be affected by turbines placed near bat swarming and hibernation sites, breeding or roosting habitats, or migration stopover areas. High levels of bat activity have been documented in forested ridge habitats, forest canopy openings, and along the shores of large waterbodies. These areas may offer attractive migratory and feeding habitat for some species of bats, which may lead to increased bat activity and mortality risk.

1.2 Regulatory Framework

The Renewable Energy Approvals Regulation establishes requirements to ensure the specific protection of significant natural heritage features, including bat significant wildlife habitat. The Renewable Energy Approvals Regulation establishes study requirements for natural features, development prohibitions and setbacks from bat SWH, and establishes the requirement for the preparation of an Environmental Effects Monitoring Plan in respect of bats. In accordance with Section 24.(2) of the Renewable Energy Approvals Regulation, the applicant must use evaluation criteria or procedures established or accepted by the MNR in undertaking work related to significant wildlife habitat, and under Section 23.1(2) they must prepare the Environmental Effects Monitoring Plan in respect of bats in accordance with this Guideline.

This Guideline establishes the criteria and procedures for class 3 and 4 wind power projects to fulfill the requirements related to bats and bat habitats established in the Renewable Energy Approvals Regulation, including:

- the process, as part of the Natural Heritage Assessment, for identifying bat habitats and determining whether they are significant wildlife habitats that require protection under the Renewable Energy Approvals Regulation;
- the identification of potential negative effects on bat SWH, specific mitigation to be applied, and the process for environmental effects monitoring for the habitat, as part of an Environmental Impact Study; and
- post-construction Environmental Effects Monitoring Plan requirements for potential negative environmental effect on bats (i.e. operational mortality), and mandatory operational mitigation in the event that the monitoring indicates a negative environmental effect occurring at a level that exceeds the mortality threshold.

As described above, MNR is responsible for establishing or accepting evaluation criteria and procedures related to natural features, including bat habitat. Under Section 28 of the Renewable Energy Approvals Regulation, the applicant must submit to the MNR all reports related to their Natural Heritage Assessment and the Environmental Effects Monitoring Plan with respect to bats. MNR is responsible for reviewing the reports and will provide written confirmation when the applicant has conducted their Natural Heritage Assessment in accordance with MNR criteria and procedures and will provide any additional comments in writing to the applicant. MNR is also responsible for providing the applicant with comments on the Environmental Effects Monitoring Plan with respect to bats. MNR confirmation and comments are required under Section 28.(3) of the Renewable Energy Approvals Regulation to be submitted to the Ministry of the Environment for a Renewable Energy Approval.

MNR's 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 bat habitat.

2.0 Assessment Process for Bats and Bat Habitats

As part of the Natural Heritage Assessment required by the Renewable Energy Approvals Regulation (Sections 24-28), wildlife habitat, including bat habitat, must be considered and addressed. Reports associated with the Natural Heritage Assessment and Environmental Effects Monitoring Plan, in respect of bats, must be submitted to MNR. Applicants must prepare the following reports and plans:

- 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 Approvals 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 bat habitat, habitat-based monitoring is required, and will be outlined in the Environmental Effects Monitoring Plan.

Applicants are required to submit all bat monitoring data and associated reports to the Ministry of the Environment, consistent with MNR's procedures and protocols, and satisfy the data standards and requirements of the Wind Energy Bird and Bat Monitoring Database. Bat survey data submitted will be

entered into the database, analyzed, reported and used to address knowledge gaps and create public data summaries.

Due to the potential negative environmental effects on bats from the operation of wind power projects, three years of annual post-construction bat 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 bat mortality (Section 4.1), operational mitigation will be required.

Figure 1 outlines the assessment process for identifying and evaluating bat habitat, addressing the potential negative effects on bats 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. This process can be coordinated with the approach used to assess and evaluate potential effects on birds.

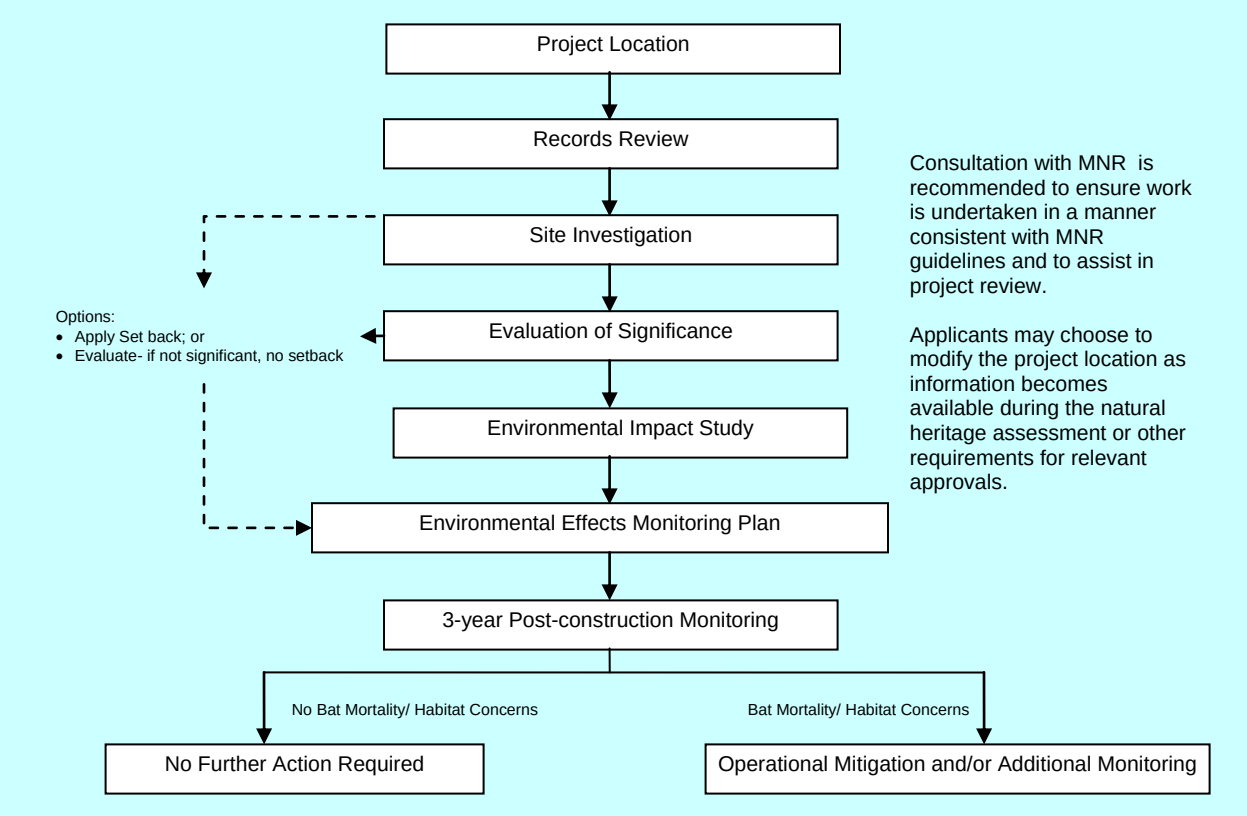

Figure 1. Bat and Bat Habitat Assessment Process (as part of Natural Heritage Assessment).

2.1 Project Location

Selecting the location for the project is generally the most important consideration to minimize potential effects to bats and their habitats. Applicants should collect and consider all available environmental bat and bat habitat-related information relevant to 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 the Renewable Energy Approvals Regulation. Wildlife habitat data collected during the records review will frequently identify habitat components (e.g. hibernacula), which may 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.

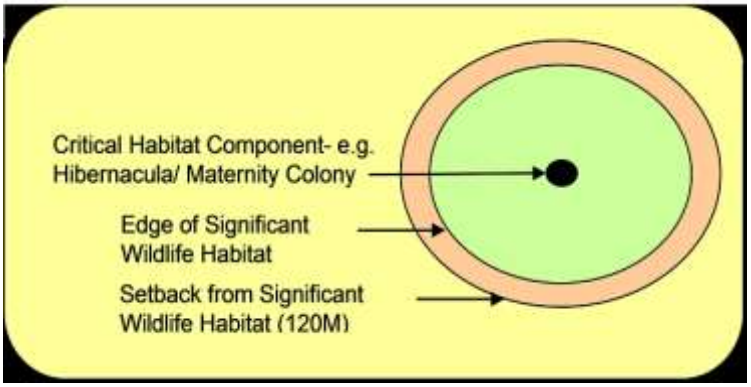

Figure 2. Defining Bat Significant Wildlife Habitat

During the records review stage of the Natural Heritage Assessment, applicants will collect all available bat and bat habitat-related information for the proposed project location, including information on bat species, candidate and confirmed bat SWH, and other relevant data. MNR will provide the applicant with any known bat information relevant to the project and encourages consideration of additional sources of information (Appendix C). Information collected during the Records Review stage should be confirmed 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.

Bat and bat SWH related information should be collected as early as possible to expedite the Natural Heritage Assessment and renewable energy approvals process.

Records review information will generally include the following bat and bat habitat data:

- species present (or likely) and relevant life cycle/history characteristics;
- information on any confirmed SWH;
- information on features associated with candidate bat SWH (e.g. caves, mines, karsts, woodlands, etc.); and
- habitat types (e.g. mapped Ecological Land Classification).

Specific information and required records to be searched are outlined in detail in the Natural Heritage Assessment Guide for Renewable Energy Projects and the Renewable Energy Approvals 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 bat SWH, and distances of project (turbines and all associated components and infrastructure) to any features of potential concern.
Appendix C lists a number of useful sources of information.

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 bat SWH is present. During the site investigation, applicants should consider habitat components originating outside of 120 metres that may have associated candidate bat 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 bat 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 bat SWH.

As outlined in Section 26 of the Renewable Energy Approvals 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 investigator(s);
- a summary of any corrections made to information collected during the records review (e.g. additional candidate bat SWH identified, etc.);
- information relating to the type, attributes, composition, and function of each bat habitat feature identified; and
- a map showing the boundaries of any identified candidate or confirmed bat habitat within 120 metres of the project location, clearly identifying its 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 bat SWH or setback, the significance of the habitat must be evaluated.

2.4 Evaluation of Significance

As per Section 27 of the Renewable Energy Approvals Regulation, an applicant who proposes a project location within 120 metres of a candidate or confirmed bat 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 Environmental Impact Study.

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 provides criteria for identifying candidate bat SWH, confirming bat SWH and defining an area that supports the form and function of bat SWH (Figure 2).
The Significant Wildlife Habitat Technical Guide identifies 3 SWH for bats:

- bat hibernacula (seasonal concentration areas);
- bat maternity colonies (seasonal concentration areas); and
- bat migratory stopover area (seasonal concentration areas.

Criteria from the Significant Wildlife Habitat Technical Guide should be used in conjunction with methods found in Appendix A for evaluating the significance of the bat hibernacula and bat maternity colonies. Criteria for confirming bat migratory stopover areas are not currently defined in the Significant Wildlife Habitat Technical Guide. In the absence of criteria, bat migratory stopover areas cannot currently be evaluated.

If a candidate bat 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 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 bat habitats prior to submitting their report, to assist in expediting the Natural Heritage Assessment.

3.0 Environmental Impact Study

An Environmental Impact Study (EIS) is required if a project location is proposed within 120 metres of confirmed bat 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 bat SWH in accordance with procedures established by MNR's Natural Heritage Assessment Guide, describing:

- any negative environmental effects of the project to bat SWH;
- mitigation measures for any negative environmental effects to bat SWH; and
- how the construction plan report and the Environmental Effects Monitoring Plan address any negative environmental effects to bat SWH.

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

General approaches to minimizing potential negative effects to bats or bat SWH include:

- careful consideration of project location relative to candidate and confirmed bat SWH;
- construction at "less-sensitive" times of the year to avoid disturbing natural bat processes and habitat; and
- restoration of habitat disturbed during construction.

Bat Hibernacula

Due to the sensitivity of bat hibernacula, applicants are advised to locate wind turbines outside of hibernacula identified as significant wildlife habitat (i.e. 1000 m from the hibernacula). An EIS must be conducted to determine appropriate mitigation should an applicant wish to locate turbines within the standard 120 m setback, or to locate other wind power project components (e.g. roads, transmission lines, etc.) within the SWH and 120 m setback.

4.0 Environmental Effects Monitoring Plan

The Environmental Effects Monitoring Plan, in respect of bats, shall be prepared in accordance with this Guideline, and will describe any bat SWH mitigation and monitoring required as determined through the EIS (where applicable). The Natural Heritage Assessment Guide for Renewable Energy projects provides of the process for considering mitigation measures for potential negative environmental effects associated with bat SWH.

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

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

- performance objectives related to negative effects to bat 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 bird surveys.

To avoid any delays in evaluating whether an application is complete, applicants should submit the post-construction mortality 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 significant bat mortality (potential negative environmental effects) resulting from the operation of wind turbines.

Bat mortality is considered by this Guideline to be significant when a threshold of annual bat mortality (averaged across the site) exceeds:

- 10 bats/ turbine/ year.

This threshold of 10 bats/ turbine/ year has been determined based on bat mortality reported at wind power projects in Ontario and comparison with jurisdictions across North America.

A monitoring year is considered to be from May 1 – October 31. Should additional bat mortality be found based on supplemental monitoring (e.g. associated with SWH) and using the same standard protocols, this mortality should be included in the calculation of mortality rates. In this case, the year is all reporting periods in one calendar year (i.e. from January 1 – December 31).

4.2 Post-Construction Monitoring

Post-construction monitoring is required for 3 years at 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 bat mortality surveys around specific wind turbines;
- monitoring of bat carcass removal rate by scavengers (or other means);

- monitoring of searcher efficiency (i.e. number of bat fatalities present that are actually detected by surveyors);
- disturbance effects monitoring (where a project is located within 120m of bat SWH); and
- an additional 3 years of effectiveness monitoring where mitigation is applied.

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 bat mortality.

Post-construction bat mortality surveys estimate bat mortality from wind turbines and may identify species and specific periods of high bat mortality. This knowledge can be used to evaluate the success of mitigation measures (i.e. siting), establish protocols for operational mitigation, and inform adaptive management.

In Ontario, the post-construction monitoring season for bats is based on bat activity patterns, covering spring activity through fall swarming and migration, and is consistent with the post-construction monitoring season for birds; thus monitoring occurs from May 1 to October 31.

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 bats are active, and in coordination with bird mortality monitoring (i.e. May 1 – October 31) for the first 3 years of wind turbine operation.
➢ Bat mortality surveys should be conducted at each monitored turbine twice per week (3 and 4 day intervals) from May 1 – October 31.
➢ Bat mortality surveys should occur at all turbines at wind power projects ≤ 10 turbines. For wind power projects of >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.
➢ Should significant mortality be observed, and operational mitigation implemented, post-construction monitoring should be conducted for an additional 3 years from the implementation of operational mitigation, to evaluate the effectiveness of the mitigation.

Post-construction monitoring should begin on May 1 of the year that the wind power project is fully operational. If full project commissioning is delayed, post-construction monitoring of a partially completed project should not be delayed for longer than 1 year. If the project is constructed in phases, monitoring for each phase should coincide with the commencement of operation of that phase. When available, post-construction monitoring data may be useful in considering potential effects on bats and bat 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 where post-construction monitoring identifies disturbance effects associated with bat SWH. Operational mitigation is required if post-construction monitoring shows that a wind power project is causing significant bat mortality. Bat mortality is considered by this Guideline to be significant when mortality levels at a project location exceed 10 bats/ turbine/ year.

Post-construction mitigation considerations for wind power developments are outlined in the Significant Wildlife Habitat Technical Guide and supporting material.

Operational Mitigation

Operational mitigation refers to adjustments made to the operation of wind turbines to help mitigate potential negative environmental effects on bats (i.e. significant bat mortality). Operational mitigation should be identified in the Environmental Effects Monitoring Plan.

Operational mitigation for bat mortality consists of changing the wind turbine cut-in speed to 5.5 m/s (measured at hub height), or feathering of wind turbine blades when wind speeds are below 5.5 m/s.

The majority of bat mortalities from wind turbine operations occur during fall migration. Across North America, it is estimated that 90% of bat fatalities occur from mid-July through September.

Where a post-construction monitoring annual report indicates the annual bat mortality threshold of 10 bats/turbine/year has been exceeded, operational monitoring will be implemented across the wind power project (i.e. at all turbines) from sunset to sunrise, from July 15 to September 30. This mitigation will continue for the duration of the project. Should site-specific monitoring indicate a shifted peak mortality period (e.g. due to higher latitude projects), operational mitigation may be shifted to match the peak mortality, with mitigation maintained for a minimum of 10 weeks. Any shift in the operational mitigation period to match peak mortality should be determined in coordination with and confirmed by MNR.

Where post-construction mitigation is applied, an additional 3 years of effectiveness monitoring is required. Monitoring the effectiveness of any post-construction mitigation techniques will help to evaluate the success of this mitigation.

Contingency Plans

A contingency plan addresses mitigation actions necessary in case of continued significant bat mortality after mitigation has been implemented. A contingency plan allows additional mitigation measures to be implemented in the event that ongoing adverse environmental effects are observed. The applicant should identify contingency mitigation actions and monitoring measures to be implemented in the Environmental Effects Monitoring Plan. Should cut-in speed mitigation be implemented and the bat mortality threshold continues to be exceeded, the applicant will work with MNR to determine additional mitigation and scoped monitoring requirements.

Appendix A: Methods for Evaluating Bat Significant Wildlife Habitat

Bat Significant Wildlife Habitat (SWH), as identified in the Significant Wildlife Habitat Technical Guide includes the following significant wildlife habitats for bats:

- bat hibernacula;
- bat maternity colonies; and
- bat migratory stopover areas.

Criteria from the Significant Wildlife Habitat Technical Guide should be used in conjunction with methods found in this Appendix for evaluating significance of the following bat SWH:

- bat hibernacula; and
- bat maternity colonies.

Criteria for confirming bat migratory stopover areas are not currently defined in the Significant Wildlife Habitat Technical Guide. In the absence of criteria, bat migratory stopover areas cannot currently be evaluated. MNR will update this Guideline as criteria for confirming bat SWH become available.

Hibernacula

Visual observations and acoustic monitoring are the most effective methods for confirming the location of bat hibernacula. Visual and acoustic monitoring can be conducted at the entrance of the hibernacula without entering the cave/abandoned mine. Due to safety issues and the disturbance risk to bats, potential hibernacula sites should never be entered.

Refer to the Significant Wildlife Habitat Technical Guide for criteria for determining the significance of bat hibernacula.

Survey Stations (for each hibernacula entrance)

- The area around the potential hibernacula should be thoroughly searched to identify multiple entrances.
- Acoustic monitoring stations should be positioned at each entrance, within 10m of the opening of the cave/ abandoned mine.
- If one entrance is found to have evidence of bats then the other entrances need not be monitored if they are part of the same structure.

Survey Period and Effort (for each entrance)

- Visual monitoring should be conducted from 10pm to midnight during the peak swarming period, from August 1-31. If swarming activity is not observed at the site on the initial visit, a minimum of 10 visits should take place to confirm that the site is not a hibernaculum.
- Acoustic monitoring should commence at dusk, for 5 hours for 10 nights from August 1 to August 31.
- Visual and acoustic monitoring surveys need only be conducted until evidence of bat presence is found. Should evidence be found on the initial surveys then further monitoring is not required. Similarly, if one method (visual observations or acoustic surveys) indicates bat presence, then the second method is not required.

Weather Conditions

- Surveys should occur on warm/ mild nights (i.e. ambient temperature above approximately 10°C) with low winds (<6m/s) and no precipitation.

Survey Equipment

- Acoustic monitoring should use modern broadband bat detectors (these may be automated systems in conjunction with computer software analysis packages or manual devices) with condenser microphones.
- Acoustic monitoring systems should allow the observer to determine the signal to noise ratio of the recorded signals (e.g. from oscillograms or time-amplitude displays). These systems provide information about signal strength and increase the quality and accuracy of the data being analysed. Zero-crossing acoustic detectors do not provide this information.
- Microphones should be positioned to maximize bat detection (e.g. microphone(s) situated away from nearby obstacles to allow for maximum range of detection, microphone(s) angled slightly away from the prevailing wind to minimize wind noise).
- It is recommended that the same brand and/or model acoustic recording system be used throughout the survey (if multiple devices are required), as the type of system may influence detection range/efficiency. If different systems must be used, this variation should be quantified.
- Information on the equipment used should be recorded, including information on all adjustable settings (e.g. gain level), the position of the microphones, dates and times by station when recording was conducted.
- Acoustic survey data should be analysed to identify species whenever possible. Unidentified species should also be included in analysis and reporting.

Other Considerations

- Bat surveys and data analysis should be conducted by a biologist experienced in bat identification and monitoring.

Maternity Colonies

In Ontario, bats use two strategies for roosting during the day. Most species roost in small spaces or crevices found in loose bark, hollow trees, rock faces and human structures such as attics, walls and bat boxes. Colonies within a natural roost may number from a few to hundreds of individuals. During the summer, females often roost in large maternity colonies while males tend to roost in small groups or individually.

Other bat species roost in foliage in small groups or individually very high up in the tree canopy and as such are often difficult to detect.

During the site investigation, the project area should be surveyed for evidence of maternity roosts. Roosts within human structures are not considered to be significant wildlife habitat.

Identifying Candidate Maternity Roosts

- Use Ecological Land Classification (ELC) to determine the presence of Mixedwood Forests or Deciduous Forests.
- Within Mixed Forests or Deciduous Forests, determine the density of snags/ cavity trees (decay class) ≥25 cm diameter breast height (dbh) within the forest site:
    - Select random plots across the represented area of the ELC plot.
    - Survey fixed area 12.6 m radius plots (equates to 0.05 hectares).
    - Measure the number of snags/ cavity trees ≥25 cm dbh in each plot.
    - Use the formula πr^2 to determine number of snags per hectare.
    - Survey a minimum of 10 plots for sites ≤10 hectares and add another plot for each extra hectare up to a maximum of 35 plots.
    - Surveys should be conducted during the leaf-off period i.e. fall to early spring (so view of tree cavities and crevices is not obscured by foliage).

- If snag/ cavity tree density is ≥10 snags per hectare of trees ≥25 cm dbh, then the site is a candidate for maternity colony roosts.

Evaluating Significance of Maternity Colony Roosts

- The level of effort required is determined according to the following factors:
    - a minimum of 10 snags/ cavity trees for areas ≤10 hectares;
    - one snag/ cavity tree for each hectare for areas ≤30 hectares; and
    - a maximum of 30 snags/ cavity trees for areas ≥30 hectares.
- The best candidate snag trees are selected according to the following criteria (in order of importance):
    - tallest snag/ cavity tree;
    - exhibits cavities or crevices most often originating as cracks, scars, knot holes or woodpecker cavities;
    - has the largest diameter breast height;
    - is within the highest density of snags/ cavity trees (e.g. clusters of snags);
    - has a large amount of loose, peeling bark;
    - cavity or crevice is high in snag/ cavity tree (>10m);
    - tree species that provide good cavity habitat (e.g. white pine, maple, aspen, ash, oak);
    - canopy is more open (to determine canopy cover, determine the percentage of the ground covered by a vertical projection of the outermost perimeter of the natural spread of the foliage of trees); and
    - exhibits early stages of decay (decay Class 1-3; refer to Watt and Caceres 1999).
- Candidate roost trees should be monitored for evidence of maternity colonies through exit surveys as follows:
    - Exit surveys should be conducted during the month of June.
    - Observers should choose a viewing station with a clear aspect of cavity opening or crevice (multiple observers may be required if multiple openings are present in one snag).
    - Cavity opening or crevice should be monitored from 30 minutes before dusk until 60 minutes after dusk for evidence of bats exiting.
    - A bat detector should be used in conjunction with visual surveys to determine species.
    - Each candidate roost tree need only be monitored once.
    - If a maternity roost is found, the entire ELC stand is considered bat SWH for the maternity colony roost.

Survey Equipment

- Refer to Hibernacula Section for survey equipment requirements

Other Considerations

- Bat surveys and data analysis should be conducted by a biologist experienced in bat identification and monitoring.

Appendix B: Post-Construction Monitoring Methods

Bat mortality surveys identify the number of bats killed per turbine over a known period of time (expressed as bats/ turbine/ year). This value represents an estimate of bat mortality adjusted for bat carcass removal rates, searcher efficiency, and percent area searched. Standard methodologies for bat mortality surveys are identified below. Maps of areas searched for each surveyed turbine and raw data for all carcass searches, searcher efficiency trials and carcass removal trials will be required as part of the annual report.

All searchers should ensure they have updated rabies pre-exposure vaccinations (contact your local health unit for details).

Minimum requirements for mortality monitoring effort and timing are found in Section 4.2 (Table 1) of this Guideline. Data collected during post-construction monitoring should be submitted in accordance with MNR data standards and templates.

Carcass Searches

Carcass searches should consider the following:

- The sub-sample of wind turbines that are monitored should include all habitat types and any significant wildlife habitat present at the site, and should cover the spatial distribution of the wind turbines. 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.) and individual searchers, but searchers should aim for a consistent search time for all surveyed turbines (e.g. 20 minutes per turbine).
- Each surveyed turbine should have a search area that has a 50m radius.
- Within this 50 metre radius, the search area should be 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.
- The search area of each turbine will be mapped into visibility classes according to the following table. It is recommended that those turbines where the majority of the search area would not be searchable due to vegetation cover or other impediments (e.g. Visibility Class 4) should not be included in the sub-sample of monitored turbines.

% 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)

- Where possible, ground cover around turbines should be maintained at a low level in order to facilitate more accurate bat mortality surveys.
- 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.
- All carcasses found should be photographed and recorded/labelled with species, sex, date, time, location (UTM coordinate), carcass condition, searcher, injuries, ground cover, and distance and direction to nearest turbine. A data sheet sample should be provided in the mortality report.
- Weather conditions including wind speed and precipitation should be included as part of the data collection.

- The estimated number of days since death, and condition of each carcass collected should be recorded in one of the following categories:
    - fresh
    - early decomposition
    - moderate decomposition
    - advanced decomposition
    - complete decomposition
    - scavenged
- Carcasses of the following species found during bat mortality searches may be stored in a freezer and used in carcass removal or searcher efficiency trials, assuming they are in reasonable condition:
    - *Lasionycteris noctivagans*
    - *Lasiurus cinereus*
    - *Lasiurus borealis*
- Because of White-Nose Syndrome contamination risks, the following species should not be used in carcass removal or searcher efficiency trials:
    - *Myotis septentrionalis*
    - *Myotis lucifugus*
    - *Myotis leibii*
    - *Perimyotis subflavus*
    - *Eptesicus fuscus*

  Carcasses of these species found during bat mortality searches may be sent to the Canadian Cooperative Wildlife Health Centre for analysis of White Nose Syndrome.

Carcass Removal Trials

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

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

- Carcass removal trials should be conducted at least once a season (spring, summer, fall), during the same period as the bird mortality surveys. Trials should be conducted once per month if vegetation changes occur during the season (e.g. crops grow, harvest, etc.).
- A minimum of 10 carcasses should be used for each trial.
- Carcasses should be monitored every 3-4 days in conjunction with carcass searches.
- Carcass removal trials should be conducted in a variety of weather conditions. Weather conditions should be recorded.
- Carcasses should be distributed across the range of different substrates/habitats and visibility classes of turbines being searched.
- To the extent possible, carcass removal trials should be conducted at turbines that are not part of the carcass search sub-sample.
- Carcasses should be placed before dusk using gloves and boots to avoid imparting human smell that might bias trial results (e.g. attract scavengers, etc.).
- Trials should continue until all carcasses are removed or have completely decomposed (generally for 2 weeks).
- To avoid confusion with turbine-related fatalities, trial carcasses should be discreetly marked (e.g. clipping of ear, wing leg, fur; hole-punching ear; etc.) with a unique identification, so they can be identified as trial carcasses.
- Carcasses used should be as fresh as possible since frozen or decomposed carcasses are less attractive to scavengers. If frozen carcasses are used, they should be thawed prior to beginning carcass removal trials.

- To the extent possible, bat carcasses should be used for at least one third of the carcass removal trials, and bird carcasses should comprise another third of the trial carcasses. Trials using other small brown mammal or bird carcasses (e.g. mice, brown chicks) may also be used when bird and bat carcasses are not available.
- 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 rates should not be assumed to be similar between sites or used in calculations for other projects.

Searcher Efficiency Trials

Searcher efficiency trials require a known number of discreetly marked carcasses to be placed 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 placed. Searcher efficiency is another important factor in creating an estimate of total bat 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 every wind power project for every year of monitoring.

Below are some important considerations for conducting searcher efficiency trials:

- Searcher efficiency trials should be conducted at least once a season (spring, summer and fall) during the same period as the bat mortality surveys. Trials should be conducted once per month if vegetation changes occur during the season (e.g. crops grow, harvest, etc.).
- A 'tester' should control the trials and return to collect marked trial carcasses at the completion of the trial to determine the number of carcasses remaining and if any carcasses were scavenged or removed during the trial.
- Searcher efficiency trials are to be conducted for each individual searcher or team involved in searching for carcasses (including teams using dogs). The searcher should not be notified when they are participating in an efficiency trial to avoid potential search biases.
- A minimum of 10 carcasses per searcher per season in all applicable visibility classes (see table above) are to be used. The average per searcher across all visibility classes will be used for calculations.
- Trial carcasses should be spread out over the trial period (month or season) and conducted with the bat mortality surveys. A maximum of 3 trial carcasses should be placed at any one time to avoid bias and flooding the area with carcasses.
- Trials carcasses are placed for one search period only and then removed and recorded by the 'tester'.
- 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.
- Trial carcasses should be discreetly marked (e.g. clipping of ear, wing leg, fur; hole-punching ear; etc.) with a unique identification so that they can be identified as a trial carcass by the tester.
- To the extent possible, bat carcasses should be used for at least one third of the carcass removal trials, and bird carcasses should comprise another third of the trial carcasses. Trials using other small brown mammal or bird carcasses (e.g. mice, brown chicks) may also be used when bird and bat carcasses are not available.
- If frozen carcasses are used, they should be thawed prior to beginning searcher efficiency trials.
- All observers, even those with trained dogs, will overlook some carcasses. This percentage will vary depending on the observer, the habitat and the area being searched, etc.

Proportion Area Searched

Based on current Ontario post-construction data, most bats appear to fall within 50m of a wind turbine base. This area therefore 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. A map of the actual search area for each turbine searched, and a description of areas deemed to be unsearchable (e.g. vegetation height, type, slope, etc.), should be provided in the mortality report.

Calculations

Scavenger Correction Factor

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

$$S_c = \frac{n_{visit1} + n_{visit2} + n_{visit3}}{n_{visit0} + n_{visit1} + n_{visit2}}$$

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:

$$S_{eo} = S_{e1}(n_1/T) + S_{e2}(n_2/T) + S_{e3}(n_3/T)…$$

S_{eo}	is the overall searcher efficiency
S_{e1} 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

Proportion Area Searched

Proportion 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 bat mortality (C) is calculated as follows:

$$C = c / (S_{e0} \times S_c \times P_s)$$

C is the corrected number of bat fatalities

c is the number of carcasses found

S_{e0} is the weighted proportion of carcasses expected to be found by searchers (overall searcher efficiency)

S_c is the proportion of carcasses not removed by scavengers over the search period

P_s is the proportion of the area searched.

Other Notes and Considerations

- The above calculations should be presented in corrected number of bats/turbine/year. In this context, the year is from May 1 to October 31.
- Should additional bat mortality be found based on supplemental monitoring (e.g. associated with SWH) and using the same standard protocols, this mortality should be included in the calculation of mortality rates. In this case, the year is all reporting periods in one calendar year (i.e. from January 1 to December 31).
- Tissue samples from bat carcasses may be used in a number of DNA analyses to provide insight into population size and structure, as well as the geographic origin of migrants. The local MNR office may be contacted prior to disposing bat carcasses, to determine if this type of research is occurring in the area.

Appendix C: Sources of Information on Bats and Wind Power

The following sources of information may be useful in providing data to assist with Records Review (Section 2.2):

Alberta Bat Action Team
http://www.srd.alberta.ca/BioDiversityStewardship/AlbertaBatActionTeam/Default.aspx

Bat Conservation International (BCI)
Up-to-date information on bat conservation, management, workshops, research, and an online library of bat resources. BCI maintains a list of bat experts throughout North America who are knowledgeable about bat ecology and behaviour, and are willing to consult on bat conservation issues.
Website: www.batcon.org

Bats and Wind Energy Cooperative (BWEC)
http://www.batsandwind.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

Collaborative Offshore Wind Research Into the Environment (COWRIE)
http://www.offshorewindfarms.co.uk/Pages/COWRIE/

Conservation Ontario
Links to all Conservation Authorities in Ontario. Conservation Authority staff may be aware of important bat 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
LIO Support: Phone: 705-755-1878 or Email: lio@ontario.ca

National Wind Coordinating Collaborative (NWCC)
http://www.nationalwind.org/

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 bats, including locations of significant hibernacula, maternity roosts, and migration corridors.
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 Internet: http://www.mnr.gov.on.ca/en/Business/LIO/index.html

Ontario Ministry of Natural Resources – Ontario Wind Resource Atlas
MNR has developed a Bat Site Sensitivity layer, which is available online through the *Ontario Wind Resource Atlas* (http://www.ontariowindatlas.ca/).This layer has been created based on the site sensitivity criteria outlined in this Guideline.

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

Ontario Ministry of Northern Development, Mines and Forestry- Geology Ontario
Information on abandoned mines in Ontario and possibly some information on bats.
Website: http://www.mndmf.gov.on.ca/mines/geologyontario/default_e.asp

Ontario Nature
Links to the Ontario Nature Network – 140 community conservation groups across Ontario. Aid in locating potential information sources on bats.
Website: http://www.ontarionature.org/

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

Western Bat Working Group
http://www.wbwg.org/index.html

Wind-Wildlife Literature Database (WILD)
http://www.nrel.gov/wind/wild.html

Appendix D: References

Arnett, E.B. 2006. Preliminary evaluation of the use of dogs to recover bat fatalities at wind energy facilities. *Wildlife Society Bulletin* **34**: 1440-45.

Arnett, E.B., K. Brown, W.P. Erickson, et al. 2008. Patterns of bat fatalities at wind energy facilities in North America. *Journal of Wildlife Management* **72**: 61-78.

Arnett, E.B., M. Schirmacher, M.M.P. Huso & J.P. Hayes. 2009. Effectiveness of changing wind turbine cut-in speed to reduce bat fatalities at wind facilities. An annual report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Betts, B.J. 1998. Roosts Used by Maternity Colonies of Silver-Haired Bats in Northeastern Oregon. Journal of Mammalogy **79**(2): 643-650.

California Energy Commission and California Department of Fish and Game. 2007. California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development. California Energy Commission, Renewables Committee, and Energy Facilities Siting Division, and California Department of Fish and Game, Resources Management and Policy Division. CEC-700-2007-008-CMF.

Campbell, L.A., J.G. Hallett & M.A. O'Connell. 1996. Conservation of Bats in Managed Forests: Use of Roosts by Lasionycteris noctivagans. Journal of Mammalogy **77**(4): 976-984.

Environment Canada – Canadian Wildlife Service (EC-CWS). 2007. *Recommended protocols for monitoring impacts of wind turbines on birds*. Environment Canada - Canadian Wildlife Service. February 19, 2007. 33 p.

Hayes, J.P., H.K. Ober & R.E. Sherwin. Survey and Monitoring of Bats. Pp 112-129. *In* T.H. Kunz & S. Parsons, editors. Ecological and behavioral methods for the study of bats. Johns Hopkins University Press, Baltimore, Maryland, USA.

Horn, J.W., E.B. Arnett & T.H. Kunz. 2008. Behavioural responses of bats to operating wind turbines. *Journal of Wildlife Management* **72**(1): 123-132.

Kerns, J., W.P. Erickson, E.B. Arnett. 2005. Bat and bird fatality at wind energy facilities in Pennsylvania and West Virginia Pp. 1-38. *In* Arnett, E.B., Technical Editor. 2005. Relationships between bats and wind turbines in Pennsylvania and West Virginia: an assessment of bat fatality search protocols, patterns of fatality, and behavioural interactions with wind turbines. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International, Austin, Texas, USA.

Kalcounis-Ruppell, M.C.,J.M. Psyllakis & R.M. Brigham. 2005. Tree roost selection by bats: an empirical synthesis using metaanalysis. Wildlife Society Bulletin **33**: 1123–1132.

Klug, B.J. & E.F. Baerwald. 2010. Incidence and Management of Live and Injured Bats at Wind Energy Facilities. Journal of Wildlife Rehabilitation **30**(2): 11-16.

Kunz, T.H., E.B. Arnett, B.M. Cooper, W.P. Erickson, R.P. Larkin, T. Mabee, M.L. Morrison, M.D. Strickland & J.M. Szewczak. 2007. Assessing impacts of wind-energy development on nocturnally active birds and bats: a guidance document. *Journal of Wildlife Management* **71**: 2449-2486.

Lacki, M.J. & J.H. Schwierjohann. 2001. Day-Roost Characteristics of Northern Bats in Mixed Mesophytic Forest. The Journal of Wildlife Management **65**(3): 482-488.

National Wind Coordinating Collaborative (NWCC). 2010. Wind Turbine Interactions with Birds and Bats: A Summary of Research Results and Priority Questions. Fact sheet: Third Edition, National Wind Coordinating Committee, Washington, D.C., 2010.

New York State Department of Environmental Conservation. 2009. Guidelines for conducting bird and bat studies at commercial wind energy projects. Prepared by New York State Department of Environmental Conservation Division of Fish, Wildlife and Marine Resources. January 2009.

Ontario Ministry of Natural Resources (OMNR). 2000. Significant Wildlife Habitat Technical Guide. Fish and Wildlife Branch. October 2000. 151 p.
Online: http://www.mnr.gov.on.ca/en/Business/FW/Publication/MNR_E001285P.html

Ontario Ministry of Natural Resources (OMNR). 2006. Wind turbines and bats: a background information document. Fish and Wildlife Branch. Wildlife Section. Peterborough, Ontario.

Ontario Ministry of Natural Resources (OMNR). 2009. Approval and Permitting Requirements Document for Renewable Energy Projects. September 2009. 64 pp.

Ontario Ministry of Natural Resources (OMNR). 2010. Natural Heritage Assessment Guide for Renewable Energy Projects. Ontario Ministry of Natural Resources. December 2010. 86 p.

Owen, S.F., M.A. Menzel, W.M. Ford, J.W. Edwards, B.R. Chapman, K.V. Miller, P.B. Wood. 2002. Roost Tree Selection by Maternal Colonies of Northern Long-eared Myotis in an Intensively Managed Forest. Published by USDA Forest Service, Newtown Square PA, March 2002.

Psyllakis, J.M. & R.M. Brigham. 2006. Characteristics of diurnal roosts used by female Myotis bats in sub-boreal forests. Forest Ecology and Management **223**: 93–102.

Smallwood, K.S., D.A. Bell, S.A. Snyder & J.E. Didonato. 2010. Novel Scavenger Removal Trials Increase Wind Turbine–Caused Avian Fatality Estimates. Journal of Wildlife Management **74**(5): 1089–1097.

Taylor, D.A.R. 2006. Forest Management and Bats. Bat Conservation International. http://www.batcon.org/pdfs/ForestMgmtandBats.pdf 16p.

Watt, R.W. and M.C. Caceres. 1999. Managing for Snags in the Boreal Forests of Northeastern Ontario. OMNR. Northeast Science and Technology. Technical Note- 016. 20p.

The Wildlife Society. 2007. Impacts of Wind Energy Facilities on Wildlife and Wildlife Habitat. Technical Review. 54p.