BATS AND BAT HABITATS

Guidelines for Wind Power Projects

March 2010

Ontario Ministry of Natural Resources

Cette publication hautement specialisée "Bats and Bat 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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1.0 Introduction

The Green Energy Act, 2009, (GEA) has placed a priority on expanding Ontario's use of clean and renewable sources of energy such as wind, water, solar, biomass, biogas and biofuels. 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 GEA 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 Approval (REA) Regulation (O.Reg. 359/09), and the Ministry of Natural Resource's (MNR) Approval and Permitting Requirements Document (APRD).

The Renewable Energy Approval 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 under MNR's Significant Wildlife Habitat Technical Guide (MNR, 2000).

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 a large number of bats of various species 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 addressing potential negative effects on bats and bat habitats during the planning, construction, and operation of wind power projects in Ontario. This Guideline supports MOE's REA Regulation and applies on both Crown and privately-owned land.

1.1 Regulatory Framework

The Renewable Energy Approval Regulation includes requirements to ensure the specific protection of significant natural heritage features (s.38 prohibitions on development for specified natural features and environmental impact studies). More generally, the Regulation provides for the ability to establish environmental effects monitoring where a negative environmental effect is likely to occur (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).

Wind power projects may have a negative effect on significant bat habitat through physical changes to the project location associated with project construction, and effects on bat populations through effects on bat movement and mortality during the operation of a facility. Appendix A provides an overview of the potential effects of wind power facilities on bats and bat habitat.

This Guideline provides both technical guidance and specific direction on how an Applicant for a Renewable Energy Approval can complete the regulatory requirements for bats and bat habitat, 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 bat habitat and determining its significance);
- The approach to protection outlined in the Regulation where a significant wildlife habitat for bats has been identified, including environmental effects monitoring for the habitat; and

- Post-construction environmental effects monitoring requirements where there may be a negative environmental effect on bats (i.e. operational mortality), and mandatory operational mitigation if this monitoring shows a negative environmental effect is occurring at a level that exceeds the mortality threshold.

MNR is responsible for establishing or accepting evaluation criteria and procedures related to natural features, including bat 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 MOE for a REA for a wind power project.

MNR's natural heritage guidance material provides procedures and evaluation criteria for conducting natural heritage assessments (NHA) and may provide additional procedural guidance relevant to the consideration of bat habitat.

1.2 Offshore

At offshore sites in Ontario, the significance of bat habitat (e.g. bat migration corridors) cannot currently be assessed. Information and knowledge related to bat movement and behaviour in offshore environments is lacking. Additionally, post-construction mortality monitoring is not feasible in offshore environments.

Although bats are known to cross the Great Lakes during their fall migration, accurate predictions regarding the effects of wind power projects on bats and/or their Significant Wildlife Habitat (bat migration corridors) at potential offshore sites cannot currently be made. Therefore, as a precautionary approach to protect bats and bat migration corridors at offshore sites, This Guide requires seasonal operational mitigation at all Class 5 (offshore) wind power projects. Section 4.2.3 provides further details on offshore operational mitigation requirements.

Research into the flight characteristics and behaviour of bats traversing the Great Lakes and other major water bodies in Ontario will provide information to improve predictive capabilities and risk assessments offshore. MNR will update bat guidance related to wind power projects in offshore environments as research results become available.

2.0 Assessment Process for Bats and Bat Habitats

Under the Renewable Energy Approval Regulation, wildlife habitat, including bat habitat, must be considered and addressed as part of the natural heritage assessment. Applicants must prepare the following reports:

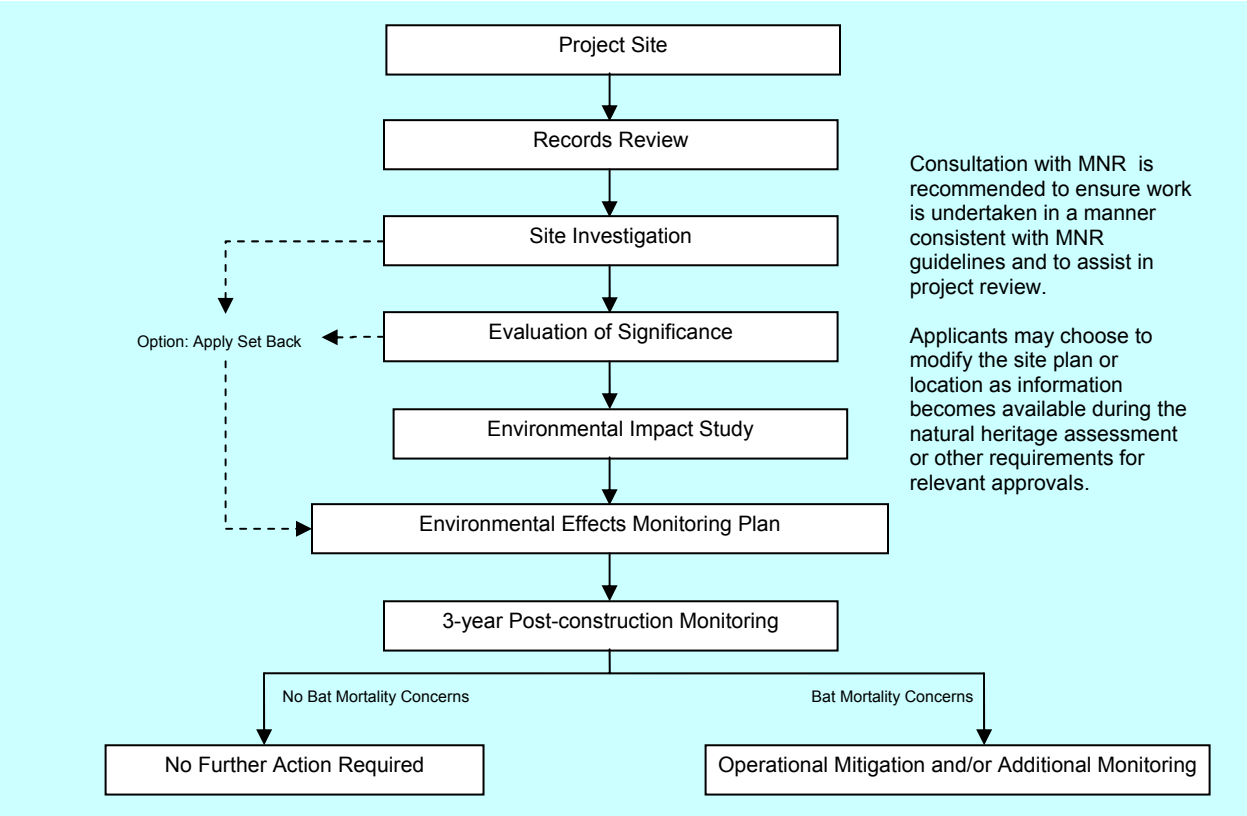
- Records Review Report
- Site Investigation Report
- Evaluation of Significance Report (if applicable)
- Environmental Impact Study (EIS) Report (if applicable; including a description of mitigation and monitoring outlined in the construction plan report and environmental effects monitoring plan)
-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

These Reports are described in the REA regulation (O. Reg. 359/09) and associated technical guidance. They 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.

Due to the potential negative environmental effects of wind power projects on bats, 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, operational mitigation will be required.

Figure 1 outlines the assessment process for potential impacts to bats and their habitats, and the minimization and monitoring of potential impacts. 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 impacts to birds.

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



2.1 Project Site

Selecting the project site is generally the most important consideration to minimize potential impacts to bats and their habitats. Applicants should consider all available environmental information when identifying a potential project site including:

- Bat habitats are characterized by very high bat activity at certain times of the year.
- Bat migratory movement occurs along natural corridors (e.g. major waterbody shorelines, constrictions of the Great Lakes, ridges, escarpments, etc.).
- Ontario evidence suggests that bat mortality appears to be highest along forested ridge tops and lakeshores of major waterbodies, moderate in open areas close to forests, and lowest in open

grassland or farmland away from forests and major waterbodies. Where possible, forested ridge tops and lake shores should be avoided during project location and planning.
- Caves and abandoned mines are often used as hibernacula or swarming sites by bats. These landscape features may be associated with higher levels of bat activity and should be investigated.
- Bats tend to be detected in higher local concentrations around bodies of water, especially during insect hatching events and in well-vegetated areas such as wetlands.

2.2 Records Review

During the Records Review stage of the Natural Heritage Assessment (NHA) process, 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. Information collected during the Records Review stage may be confirmed during the Site Investigation and during the Evaluation of Significance (where applicable). In most cases, much of the required detailed site 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. Some of the information requirements for bats and birds are the same, and the applicant may incorporate these into a single collection process to reduce workload.

Records Review information will generally include:

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 SWH (e.g. caves, abandoned mines, karst topography, forested ridges, wetlands, woodlands, major waterbodies, etc.)
- habitat types (e.g. Ecological Land Classification)

Other Data

- potential feeding areas with documented high insect activity or abundance
- other natural heritage features in near proximity to the proposed development
- proposed and/or potential locations/placement of wind turbines
- proximity to existing wind farms

The Records Review report will include mapping products and spatial data that identify project location and study area boundaries, potential turbine placements, 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.

MNR has developed a 'known bat hibernacula layer', which is available online through the *Renewable Energy Atlas*. This layer identifies confirmed bat hibernacula, and will be periodically updated. Appendix E lists a number of useful sources of information.

2.3 Site Investigation

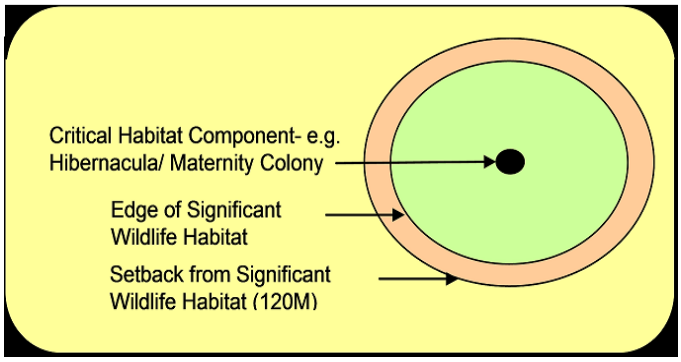
The applicant will ensure that a physical investigation of the air, land and water within 120m of the project location is documented, and will determine if additional candidate bat SWH is present. Habitat boundaries for candidate and confirmed SWH should be mapped during the site investigation stage and the distance between natural features and project location indicated.

MNR's Significant Wildlife Habitat Technical Guide (SWHTG) (MNR, 2000) identifies and defines bat SWH, and outlines procedures to assist in completing the Site Investigation Report requirements. It is important to refer to the SWHTG at this stage to identify candidate and confirmed bat SWH.

2.4 Evaluation of Significance

The SWHTG provides criteria for identifying candidate and confirmed bat SWH and defining an area that supports the form and function of bat SWH (Figure 2).

Figure 2. Defining Bat Significant Wildlife Habitat



Criteria from the SWHTG should be used in conjunction with methods found in Appendix C for evaluating significance of the following bat SWH:

- Bat hibernacula (seasonal concentration areas)
- Bat maternity colonies (seasonal concentration areas)

Criteria for confirming the following bat SWH are not currently defined in the SWHTG. In the absence of criteria, the following bat habitats cannot be evaluated:

- Bat migration corridors (seasonal concentration area)
- Bat movement corridors (animal movement corridors)

To address potential negative environmental effects to bats and bat migratory habitats, operational monitoring and/ or mitigation are required elements of an Environmental Effects Monitoring Plan (Section 4.0).

All available information from the records review and site investigation should be applied to methods identified in Appendix C to evaluate bat SWH.

An evaluation of significance is not required if the project location is at least 120m from a candidate or confirmed SWH.

If a candidate bat SWH is evaluated and confirmed within the project location, applicants may setback 120m or conduct an Environmental Impact Study (section 6.0) as part of the NHA process to determine whether potential negative environmental effects can be avoided or effectively mitigated.

Applicants are encouraged to contact MNR to verify the evaluation of significance of bat habitats prior to submitting their report, to assist in expediting the NHA review process.

3.0 Environmental Impact Study

An Environmental Impact Study (EIS) is required if a project location is proposed within 120m of confirmed SWH. An EIS must be prepared in accordance with procedures established by MNR, 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 SWHTG 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 placement and distribution/arrangement of wind turbines, roads, power lines, etc. within the project location;
- avoidance of wind turbine placement near water or in riparian habitat in an otherwise dry area, as bat activity and collisions are expected to be higher in these areas;
- construction at “less-sensitive” times of the year to avoid disturbing natural bat processes and habitat;
- habitat disturbed during construction should be restored to a functional state once construction is complete.

Bat Hibernacula

Due to the sensitivity of bat hibernacula, this Guide recommends applicants locate wind power projects outside of hibernacula identified as significant wildlife habitat (i.e. 200 m from the hibernacula). An EIS should be conducted to determine appropriate mitigation should an applicant wish to locate within the standard 120 m setback from the significant wildlife habitat.

4.0 Environmental Effects Monitoring Plan

The Environmental Effects Monitoring Plan will describe any bat SWH mitigation and monitoring required as determined through the EIS (where applicable).

In addition, for all wind power projects, the EEM will outline the post-construction mortality monitoring plans that are required for a minimum of 3 years to address potential negative environmental effects to bats.

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 C.

4.1 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 D.

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); and
- monitoring of searcher efficiency (i.e. number of bat fatalities present that are actually detected by surveyors).

Search 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 specific periods of high bat mortality. This knowledge can be used to evaluate the success of mitigation measures (i.e. siting) and establish protocols for operational mitigation, as well as to inform the placement of future wind turbines.

In Ontario, the post-construction monitoring season for bats is based on bat activity patterns, covering spring activity through fall migration; thus monitoring occurs from May 1 to September 30.

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) during the core season when bats are active (i.e. May 1 – Sept. 30) for the first 3 years (for each phase) of wind turbine operation. ➢ Bat mortality surveys should be conducted at least every 3 days at each monitored turbine. ➢ 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 turbines should be selected to cover representative areas throughout the project area. ➢ Should significant mortality be observed, and operational mitigation implemented, post-construction monitoring should continue for an additional 3 years from the implementation of operational mitigation, to evaluate the effectiveness of the mitigation.

Post-construction 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, 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 impacts of the entire wind power project can be assessed. When available, post-construction monitoring data may be useful in considering potential impacts to bat and bat habitat in adjacent phases.

Post-construction monitoring reports should be submitted to Ministry of Environment for each monitoring

year as part of the Environmental Effects Monitoring Plan.

4.2 Post Construction Mitigation

Post-construction mitigation and contingency plans are to be identified in the Environmental Effects Monitoring Plan. 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 Guide to be significant when mortality levels exceed 10 bats per turbine per year.

4.2.1 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. bat mortality events), before they become significant.

A threshold of 10 bats per turbine per year has been established by this Guide. This threshold (10 bats/turbine/year) has been determined based on bat mortality reported in surveys throughout Ontario and comparison with jurisdictions across North America.

4.2.2 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. 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, 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 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 from sunset to sunrise, from July 15 to September 30. This mitigation will continue for the duration of the project.

Operators may also choose to coordinate turbine shutdown for maintenance with periods of high bat activity and/or mortality to reduce operational impacts. Monitoring the effectiveness of any post-construction mitigation techniques will help to evaluate the success of this approach.

4.2.3 Offshore Operational Mitigation

This Guide establishes that in the absence of post-construction bat mortality monitoring, operational mitigation will be applied at all offshore wind power sites during the fall bat migration season. Thus all offshore turbines should increase cut-in speed to 5.5 m/sec, or feather turbine speeds when wind speeds are below 5.5 m/s, from July 15 to September 30, from sunset to sunrise. This mitigation will continue for the duration of the project.

4.2.4 Contingency Plans

A contingency plan addresses immediate mitigation actions necessary in case of large, unforeseen levels of mortality. A contingency plan allows mitigation measures (e.g. temporary blade feathering or operational mitigation) to be implemented in the event that unanticipated adverse environmental effects are observed. The applicant should identify contingency mitigation actions in the Environmental Effects Monitoring Plan.

Appendix A: 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, wind power project studies have reported annual mortality estimates varying from 4 to 14 bat mortalities/turbine/year. Wind power projects in the United States have reported bat mortality with annual mortality estimates varying from between 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 may be attracted to the area of the turbines and do not appear to avoid the rotating blades;
- bats can range widely across landscapes and migrate long distances, which may make them more susceptible to cumulative impacts;
- 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 bat populations particularly vulnerable to increased mortality.

Direct and indirect effects of wind power projects on bats and bat habitats are described below.

Direct Effects

General observations to date indicate that bats do not typically collide with turbine towers, transmission structures, guy wires, or meteorological towers (e.g. stationary structures), but may collide with turbine blades. The majority of bat fatalities at wind power sites occur in the late summer and early fall, and long-distance migratory bats (i.e. hoary bat, eastern red bat, silver-haired bat) appear to be most vulnerable to collisions with moving turbine blades. Northern Ontario studies to date report similar mortality for both migratory and resident bats.

Bats can also be killed by barotrauma (internal haemorrhaging) caused by rapid air pressure reduction near moving turbine blades. Air pressure change at turbine blades is an undetectable hazard, which may cause high bat fatality rates and help explain why bats may be more susceptible to wind turbine mortality than birds.

Four main factors appear to contribute to bat mortality at wind power projects:

- species and abundance in the area;
- time of the year;
- habitat/landscape features in the area; and
- weather conditions, including wind speed.

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. Appropriate project location appears to be a key factor in minimizing impacts on bats.

Bat habitat may be directly impacted by the footprint of turbines, roads, transition lines, and auxiliary buildings. Deforestation for turbines, roads, maintenance yards and transition lines can remove woodland habitat important to breeding or roosting bats. Movement corridors can be impeded by turbines placed in the way of bats accessing important feeding, breeding or roosting habitats, or migration routes. High levels of bat activity have been documented in forested ridge habitats and forest canopy openings created for wind turbine placement. These areas may offer attractive migratory and feeding habitat for some species of bats, which may lead to increased bat activity and mortality.

Indirect Effects

Bats may be displaced from suitable habitat due to direct loss or fragmentation of feeding, breeding, or migratory stopover habitat during the construction and/or operation of a project, or due to the active avoidance of structures, human activity, or noise (e.g. construction activities, roads, turbines, cut forest edges). Habitat fragmentation (edge habitat) created by wind power projects may also attract bats into an area and subsequently increase the incidence of bats interacting with wind turbines.

Appendix B: Best Management Practices

This Guide encourages wind power developments to adopt the best management practices outlined below, to improve the understanding and management of bat populations

- 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 impacts of wind turbines on bats, allow for greater consistency in assessment of wind power impacts and lead to future improvements in approval processes. The database is designed to allow individual industry applicants and/or their consultants to enter bat survey data in a confidential environment, while providing the ability to analyse the data and create summaries for the public on the website.

- Carcasses of the following species found during bat mortality searches may be sent to the Canadian Cooperative Wildlife Health Centre for analysis of White-nose Syndrome.
    - *Myotis septentrionalis*
    - *Myotis lucifugus*
    - *Myotis leibii*
    - *Perimyotis subflavus*
    - *Eptesicus fuscus*

- 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 bird mortality studies provided the considerations described in this Guideline are given to bats. 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

- 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 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: Methods for Evaluating Bat Significant Wildlife Habitat

Bat Significant Wildlife Habitat (SWH), as identified in the Significant Wildlife Habitat Technical Guide (SWHTG) includes:

- Seasonal concentration areas: bat hibernacula, maternity colonies and bat migration corridors
- Animal movement corridors: bat movement corridors

Criteria from the SWHTG should be used in conjunction with methods found in this Appendix for evaluating significance of the following bat SWH:

- Bat hibernacula (seasonal concentration areas)
- Bat maternity colonies (seasonal concentration areas)

Criteria for confirming the following bat SWH are not currently defined in the SWHTG. In the absence of criteria, the following bat habitats cannot be evaluated:

- Bat migration corridors (seasonal concentration area)
- Bat movement corridors (animal movement corridors)

MNR will update this Guide as criteria for confirming bat SWH become available.

Hibernacula

Visual observations and acoustic monitoring are the most effective methods for determining the significance of bat hibernacula. Visual observations can be made at the entrance of the hibernacula without entering the cave/abandoned mine. Due to safety issues and the disturbance 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 entrance)

- Acoustic monitoring stations should be positioned within 10m of the entrance of the cave/abandoned mine. The area should be searched thoroughly to identify whether there are multiple entrances and acoustic monitoring stations should be positioned at each entrance.

Survey Period and Effort (for each entrance)

- Visual monitoring should be conducted between the hours of 10pm to midnight during the peak swarming period in August. If swarming activity is not observed at the site on the initial visit, a minimum of 10 visits should take place to confirm if the site is not a hibernacula.
- Acoustic monitoring should commence at dusk, for 5 hours for 10 nights from August 1 to August 31 and 5 additional nights from September 1 to September 30.

Weather Conditions

- Surveys should occur on warm/mild nights (i.e. ambient temperature above approximately 10°C) with low winds (<10m/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.

Survey Data
- Acoustic survey data should be analysed to identify species whenever possible. Any unidentified species should also be included in analysis and reporting.
- Collected information should include the total and mean bat passes (i.e. sequence of two or more echolocation calls) per detector hour and per night as a function of bat activity at the survey station.

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 roost may number from a few to thousands 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 notice.

During the site investigation, the project area should be surveyed for evidence of maternity roosts.

Survey Stations
- Acoustic monitoring stations should be positioned within 10m of the potential roost. Multiple stations should be used to cover the area adequately (1 station/km^2).

Survey Period and Effort
- Visual monitoring should be conducted at dusk in June. If 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 roost or maternity colony.
- Acoustic monitoring should begin at dusk and continue for 5 hours, for up to 10 nights, or until a roost is confirmed. Monitoring should occur between June 1 and June 30.

Weather Conditions
- Surveys should occur on warm/mild nights (i.e. ambient temperature above approximately

10°C) with low winds 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.
- 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.

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Other Considerations

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

Appendix D: Post Construction Monitoring Methods

Bat Mortality Survey

Bat mortality surveys identify the number of bats killed per turbine over a known period of time (expressed as bats/turbine/time). This value represents a minimum 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.

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

Bat mortality surveys should consider the following:

- To avoid delays in evaluating whether an environmental effects monitoring plan is complete, applicants should submit Post-construction monitoring designs for MNR review prior to commencing turbine construction.
- 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.
- Each surveyed turbine will have a 50m search radius and the complete area will be searched.
- 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.
- 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.
- Searcher efficiency trials should be conducted for all searchers.
- Additional survey requirements (e.g. increased trials, longer search times, etc.) may be necessary in complex habitats where bat 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 (UTM coordinate), carcass condition, searcher, injuries, distance to nearest turbine, ground cover 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 scavenged, with portions of it (for example, wings, skeletal remains, legs, pieces of skin) found in more than one location
- 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*

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 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.

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

- Carcass removal trials should be conducted at least once a month during the same period as the bat mortality surveys
- A minimum of 10 carcasses should be used for each trial.
- Carcasses 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 turbines being searched.
- Carcasses should be placed before daylight using gloves and boots 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 (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 a study carcass.
- 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.
- Bat carcasses should be used for at least one third of the carcass removal trials. Trials using other small brown mammal or bird carcasses may also be used.
- 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 all sites.

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 bat mortality surveys. More trials should be conducted if vegetation changes during the season (i.e. crops grow, harvest). If changes are expected, searcher efficiency trials should be conducted once per month.
- A minimum of 10 carcasses per searcher per visibility class (see table above) are to be used. These trial carcasses can be spread out over the trial period and conducted with the bat mortality surveys. The average per searcher across all visibility classes will be used for calculations. Raw data for all searchers will be required with the annual report.
- 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; hole-punching ear; etc.) with a unique identification so that they can be identified as a study 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.
- Bat carcasses should be used for at least one third of the searcher efficiency trials. Trials using other small brown mammal or bird carcasses may also be used.
- If frozen carcasses are used, they should be thawed prior to beginning searcher efficiency trials.

Percent 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.

In cases where the entire 50m radius cannot be searched, it is recommended that the density of distribution of carcasses be calculated as part of the overall estimated mortality. Studies have shown that a larger percentage of carcasses fall closer to the turbine base and that the number of carcasses decreases with increasing 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:

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

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:

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

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:

$$S_{eo} = S_{e1}(n_1/T) + S_{e2}(n2/T) + S_{e3}(n_3/T)…$$

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

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 bat mortality (C) is calculated as follows:

$$C = c / (S_e \times S_c \times P_s)$$

C is the corrected number of bat 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 bats/turbine/year. In this context, the year is from May 15 to September 30.
- Bat 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.

Appendix E: 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 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

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 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 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- Abandoned Mines Rehabilitation Program
Information on abandoned mines in Ontario and possibly some information on bats.
Website: http://www.mndm.gov.on.ca/mndm/mines/mg/abanmin/abanpro2_e.asp

Appendix F: Other Sources of Information on Bats and Wind Power

Alberta Bat Action Team
http://www.srd.gov.ab.ca/fishwildlife/wildlifeinalberta/batsalberta/abat.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/

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

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

Ontario Ministry of Natural Resources
Wind Power and Bats: Bat Ecology Background Information and Literature Review of Impacts (MNR 2006) provides a summary of: bat species of Ontario – biology and habitat; potential impacts of wind power projects on bats; and general site survey methodologies.

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