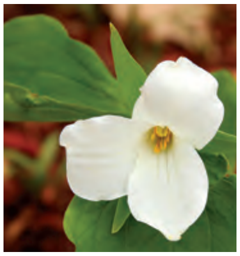
SIGNIFICANT WILDLIFE HABITAT MITIGATION SUPPORT TOOL

VERSION 2014



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WHAT IS THE SIGNIFICANT WILDLIFE HABITAT MITIGATION SUPPORT TOOL?

The Significant Wildlife Habitat Mitigation Support Tool (SWHMiST) is a tool intended for use by planners as a guide to help them understand the functions of habitat, potential impacts, and possibilities for mitigation. Planning authorities may request natural heritage studies if the proposed development occurs in or adjacent to areas that have been designated as significant wildlife habitat (see the Significant Wildlife Habitat Technical Guide, OMNR 2000). Significant wildlife habitat (SWH) includes: seasonal concentration areas; rare vegetation communities or specialized habitats for wildlife; movement corridors; and the habitat of species of conservation concern. The SWHMiST is used after the site has been identified as being a natural heritage feature.

The following information is provided as a means of verifying predictions made by proponents regarding the impact of proposed development on significant wildlife habitat. The Natural Heritage Policy states that development can occur in and adjacent to areas identified as significant wildlife habitat provided that it has been demonstrated that there will be no negative impact on the natural features and ecological functions of the area.

The information contained in this mitigation support tool outlines the habitat needs of species or groups requiring similar significant wildlife habitat features. The function of significant wildlife habitat is described for each species or group. For example, certain woodlands function as winter concentration areas for white-tailed deer. Deer migrate seasonally to these areas, and by doing so, they increase their chances of surviving the winter. Information is provided about the composition and structure of woodlands which allow them to function as winter concentration areas for deer. The SWHMiST also provides information regarding anticipated impacts of development on significant wildlife habitat as well as information about possible mitigation techniques.

The information within SWHMiST provides advice and recommendations for mitigating development effects in and adjacent to SWH. The direction found within this support tool is based on the best available information and does not limit the use of other relevant mitigation information. Users of the SWHMiST will need to check regularly for a current version. This support tool will require periodic updating to keep pace with changes to wildlife species status in the Species at Risk in Ontario (SARO) list, or as new scientific information pertaining to the mitigation of wildlife habitats becomes available. Therefore, Ontario Ministry of Natural Resources (OMNRF) will occasionally need to review and update this support tool and provide an updated version.

ACKNOWLEDGEMENTS

This version of the Significant Wildlife Habitat Mitigation Support Tool has been built on the contributions of Kerry Coleman (OMNRF), Al Sandilands (Biological Consultant) and Tim Haxton (OMNRF) in 2000. Editors of the updated 2014 version included John Boos (OMNRF), Andrew Jobes (OMNRF), Natasha Carr (OMNRF), Diana Abraham (ESSA Technologies Ltd.) and Al Sandilands (Grey Owl Consulting). Information, review and expertise to the various indices was provided by David Webster, Ken Abraham, Don Sutherland, Dawn Burke, Brent Patterson, Brian Naylor, Mike Oldham, Colin Jones, Lauren Trutte, Wasyl Bakowsky, Shaun Thompson, Anne Yagi and Fiona McGuiness. Various sections within OMNRF provided resources and staff time towards completing this update and include: Regional Planning Units, Land Use and Environmental Section, Renewable Energy Section, Species at Risk Program, Natural Heritage information Center, OMNRF Science and Information Transfer, and District field offices. We would like to thank all OMNRF staff that provided comments and reviewed the Indices.

HOW THE SWHMIST WORKS

The Significant Wildlife Habitat Mitigation Support Tool is meant to accompany the Significant Wildlife Habitat Technical Guide (OMNR 2000). All topics of the Significant Wildlife Habitat Mitigation Support Tool can be reached through the Table of Contents. The Table of contents is linked to Indices for Significant Wildlife Habitats, each index has links to specific development types and to habitat descriptions for species that are found using the habitat.

USING A LANDSCAPE ECOLOGY APPROACH

As part of a landscape ecology perspective, OMNRF in addition to the SWH Technical Guide (OMNR 2000) has developed SWH Ecoregional Criteria Schedules (OMNRF 2014). These schedules are a compilation of significance criteria for wildlife habitats within ecoregions of Ontario. The SWHMiST indices outline the ecoregions that currently have completed ecoregional schedules. Ecoregions that presently do not have schedules will reference the SWH Techincal Guide (OMNR 2000) for significance criteria. When a SWH is identified in ecoregions with or without schedules the information provided in the SWHMiST can be considered.

Proponents and reviewers of Impact Assessments should always try to put the development proposal and its impacts into a landscape perspective. All too often, proponents simply state that there is abundant suitable habitat in the area and that wildlife will move to these areas. If this is used as rationale that the development will have no negative impacts, the proponent must be able to demonstrate where other suitable habitat is, that wildlife will actually have access to it, and that the other areas are not at carrying capacity. The reality is that, if two pairs of a bird species breed in a habitat that will be removed by development, there will likely to be two fewer pairs of that species nesting in the province in future. It is the decision of the planning authority to determine if the loss of two pairs is acceptable, or the onus is on the proponent to demonstrate that there actually will not be a loss.

Significant wildlife habitat must not be considered in isolation from other natural heritage features. For example, a forested valley with a watercourse running through it could contain several natural heritage features. The planning authority could designate the valley as a significant valleyland and significant woodland. The watercourse would probably be fish habitat. Within the valley, there could be several sites that would qualify as significant wildlife habitat.

It is important to consider that an area will frequently function in more than one way as significant wildlife habitat. The interactions among these habitats and significant features must be considered in an Impact Assessment.

SPECIES HABITAT REQUIREMENTS

Groups of species, or guilds, are often considered together within a single index or habitat. It is important to do this so that the SWHMiST does not become too complicated and unwieldy. Although grouping of species with similar habitat requirements, or that use a certain habitat type, is essential to streamlining the system, this causes some problems when attempting to generalize habitat requirements, potential impacts of development, and Mitigation Options. The habitat requirements of individual species within a guild may vary substantially. Within broad habitats or guilds of species, mitigation to protect one species may be detrimental to another. An attempt has been made to deal with this by providing descriptions of the pertinent habitat requirements of each species within guilds in an Appendix at the end of the SWHMiST. This provides proponents and reviewers with information on which of the species in the proposed development area may qualify under the significant wildlife habitat component of the PPS, and what conditions should be maintained if that species is to remain on site.

The Appendix of habitat requirements for individual species within a guild also helps to identify which species are most sensitive to development pressures. For instance, if one of the species documented as being present typically requires a field that is 75 ha in area, it will be much more likely to be affected by a reduction in field size than a species that is content in fields as small as 10 ha. In most cases, if habitat is protected for the most sensitive species, all others will also be protected.

The species listed under each guild are intended to be all-inclusive. Therefore, in some areas of the province, many of the species would not be considered significant. Determination of which species are significant should be made using the significant wildlife habitat identification guidelines prepared by OMNR in 2000. The significance of many species will vary across the province depending upon their normal geographic range and the availability of suitable habitat within this range. In other words, a species may be common in the main portion of its range where there is ample suitable habitat, but may be a significant species at the periphery of its range or where habitat has been reduced. The significant wildlife habitat component of the PPS applies throughout the province. For the sake of completeness, we have included all species that fit within the guild. For those that occur only in areas that are unlikely to be affected by development, such as on the Hudson Bay Lowland, detailed habitat requirements are not presented.

There are also some species that are at risk because of certain characteristics of their life history, even though they may be extremely abundant in some areas. Prime examples are some of the colonially-nesting bird species such as Ring-billed Gull. In some areas, this species may approach nuisance levels and municipalities may choose not to consider their habitat to be significant. In areas where they are not common, nesting areas may be significant wildlife habitat.

We have provided the most up-to-date information possible on species' habitat requirements. However, the habitat needs of many species are poorly understood. Additionally, much of the literature is from the United States, and species' preferences there may be different than in Ontario. The reality is that species adapt over time to the general characteristics of the landscape in which they occur. Some of the bird species documented as requiring 100 ha or more in the northeastern states inhabit much smaller patches in Ontario and reproduce just as successfully. In southern Ontario, the Winter Wren is a forest-interior bird that seldom occurs near edge; on the Canadian Shield, it often occurs on lake and river shorelines in areas that would be avoided in the south. In the United Kingdom, the wren is found in backyards.

One of the habitat components important to species' abundance and productivity is minimum patch size. This also varies across the province depending on the amount of natural habitat within the general landscape. In an agricultural landscape that is over 30% forested, a species may inhabit patches as small as 10 ha, but the same species may require 30 to 50 ha in regions where forest cover is sparse. This emphasizes the importance of maintaining as much forest cover as possible within a planning area. When giving estimates of habitat size requirements, we have tried to give an average that might typically be inhabited in areas with about 15 to 20% forest cover. Therefore, if the study area has less forest cover, the species is likely to require larger forests; smaller areas may be suitable where there is a higher percentage of forest cover.

The habitat requirements presented in the SWHMiST should not be considered absolute. Not only is there insufficient information for some species, habitat requirements may vary geographically and according to the quality of the landscape. Possibly the most important variable is the fact that we are trying to characterize habitat requirements for all individuals of a given species across the entirety of the species' range in Ontario. The reality is that each species is comprised of a population of individuals, and that some will select habitat conditions different from most individuals of the species. These individuals often are successful in what we would consider abnormal habitat for them. To put it into context, what we are presenting is the equivalent of summarizing the habitat requirements of humans under four or five headings. It can be done in a general sense, but there will always be exceptions. The information provided in the SWHMiST is based on what the literature defines as typical habitat.

The descriptions of habitat requirements will always be a work in progress. As new information comes to light, the information in the Appendix will be updated. Users of the SWHMiST are urged to inform us of information that could improve this part of the system.

POTENTIAL DEVELOPMENT EFFECTS AND MITIGATION OPTIONS

In this portion of each index, we have presented Potential Development Effects for 5 development categories (see below) and described applicable Mitigation Options for each. We have included all 5 development categories in each index, regardless of whether or not they are all relevant, to standardize the indices and make it easy for users to find the information they need.

In terms of development effects, we have attempted to present all potential effects that development may have on the significant wildlife habitat and species that are dealt with by each index. Each development proposal will be unique to some extent, and there are undoubtedly potential impacts that we have not identified. Proponents and reviewers should ensure that additional potential effects of development are considered. These should also be identified to the Ministry of Natural Resources so that the SWHMiST can be updated.

The indices deal only with potential effects of development on significant wildlife habitat. When preparing an Impact Assessment, proponents will also have to identify potential impacts on other natural heritage features such as significant wetlands, significant Areas of Natural and Scientific Interest, significant woodlands, significant valleylands, significant portions of the habitat of threatened and endangered species, and fish habitat.

Under the Planning Act, development means consents, subdivisions, and industrial and commercial developments, or basically anything that involves an application under the Planning Act. Proponents and reviewers may be able to use the potential impacts identified in the indices as a checklist to determine if the proposed development will result in any of the effects identified. The onus is on the proponent to demonstrate that negative impacts will not occur to significant wildlife habitat. If potential negative impacts are identified, then the proponent must demonstrate that these impacts can be mitigated.

An Impact Assessment should consider the ultimate end product of a development, and assume the worst-case scenarios. For instance, if a subdivision will be built over four phases, the potential impacts of the entire development should be addressed as opposed to dealing with each phase individually. If the proposal is for cottage lot development, it could be assumed that these will be converted into year-round residences. Occasionally these types of developments are approved, thinking that significant wildlife habitat, such as deer wintering areas, will not be affected because there will be no human use during the winter. This often results in an underestimation of the true impacts of a development. Also, all aspects of the development should be considered, including site preparation, construction, and the final use. Previous development may have already reduced the quality of significant wildlife habitat, and further development may have additional impacts or result in loss of functions that would not have occurred without the previous development.

THE MAIN TYPES OF DEVELOPMENT ADDRESSED IN THE SWHMIST ARE:

Residential and Commercial Development:

The extent of potential development impacts is a function of scale (single vs. multiple lots or large commercial spaces) and landscape context (cottage vs. urban). Residential development can reduce habitat quality or destroy it altogether. Changes in forest composition and structure, draining and filling to create building sites, removal of woody debris from waterways, clearing of shorelines to create beaches and install docks, fire suppression to protect property values, and increased human and pet populations all contribute to degrading habitat quantity and quality. Commercial development types involve significant site alteration (clearing, leveling) and the creation of large impervious surfaces (e.g., parking lots) on the landscape. Tall buildings also present hazards for migrating birds and bats, particularly when lit at night.

Major Recreational Development:

This type of development includes such things as golf courses, parks, serviced playing fields, serviced campgrounds and recreational resorts. Although site alteration is inevitable, it may be possible to avoid the destruction of significant wildlife habitat through proper design and location.

Aggregate and Mine Development:

The aggregate industry is encouraged to avoid, replace or enhance significant wildlife habitat during/following operations. Quarrying results in direct habitat losses through removal of vegetation, rock and soil, and through hydrologic changes and the construction of berms. Rehabilitation of these projects can, however, create new barrens, cliff and talus habitats.

Energy Development:

Wind power facilities and solar farms are relatively new forms of development in Ontario. Information about habitat-specific impacts and mitigation is very limited, particularly for solar farms. Habitat losses around wind power facilities accrue directly from the footprint of the development and indirectly from avoidance of the area by wildlife. Energy projects that involve damming result in the flooding of riparian habitats or the conversion of shallow water into deeper water. Damming of waterways is done for various reasons, including flood control, to store water for power generation and to enhance wetland habitat for waterfowl. Flooding of lands adjacent to managed waterways results in a loss of existing terrestrial and shoreline habitat, but creates new open water and wetland habitat.

Road Development:

This type of development involves dramatic site alteration, drainage of the road corridor and alteration of the water regime in adjacent habitats, the introduction of contaminants into surface runoff, and the creation of impervious surfaces on the landscape. Roads also bisect the landscape and present crossing hazards for wildlife and potential barriers to movement.

The best form of mitigation is to avoid development in significant wildlife habitat. This, however, is not always possible. When significant wildlife habitat may be affected by development, the proponent must identify mitigation techniques that will reduce effects to acceptable levels.

For each of the potential impacts identified in an index, possible mitigation methods are suggested. Many proponents will identify innovative mitigation measures that we have not considered. These should be described to the Ministry of Natural Resources so that the SWHMiST can be updated.

TERMS AND CONCEPTS

Wildlife - includes all non-domestic living organisms, from mammals to plants to bacteria. This decision support system has focused on insects, amphibians, reptiles, birds, and mammals.

Wildlife Habitat - is “home”. It means areas where plants, animals and other organisms live, and find adequate amounts of food, water, shelter, and space needed to sustain their populations. Specific wildlife habitats of concern may include areas where species concentrate at a vulnerable point in their annual or life cycle; and areas which are important to migratory or non-migratory species.

Significant Wildlife Habitat - Determining what constitutes significant wildlife habitat will vary across the province because of differences in the distribution of wildlife species, and the amount, distribution and quality of the habitat that remains. For example, winter deer habitat may be considered highly important in jurisdictions having relatively few winter concentration areas (deer yards), but less important in others with many yards. Technical guidelines (OMNR 2000) have been developed to assist planning authorities to identify and evaluate significant wildlife habitats in their areas.

Significant wildlife habitat is identified and evaluated for individual species and/or groups of species in the following categories:

Seasonal Concentration Area (SCA) - areas where animals occur in relatively high densities at specific periods in their life cycle and/or in particular seasons. Impacts which occur at sites of seasonal concentration have the potential to affect wildlife populations well beyond the site level.

Rare or Specialized Habitat (RSH) - rare vegetation communities (prairies, alvars, savanna, etc.) or habitats which satisfy specific life requirements of animals (i.e., mineral licks, aquatic feeding areas, etc.). Elimination of these rare or specialized habitats from the landscape reduces the quality of wildlife habitat. In some cases the loss of these features may result in the total loss of habitat function for the species of concern.

Habitat of Species of Conservation Concern (HSCC) - includes significant portions of the habitat of species that are rare, substantially declining, or have a high percentage of their global populations in Ontario. Since these species are living at low density, often in small localized areas, they are prone to extinction following relatively minor habitat disturbances. Many of the species in this group are intolerant of human activity. This presents a great challenge to mitigation.

Movement Corridor (MC) - habitat which links two or more wildlife habitats that are critical to the maintenance of a population of a particular species. Many wildlife populations depend on the process of dispersal to move individuals among sub-populations scattered throughout the landscape. Movement of animals serves to prevent inbreeding which results in less variation in the genetic makeup of the population. Populations with low genetic diversity are less able to adapt to changing environmental conditions and hence are more prone to extinction. Additionally, otherwise suitable yet unoccupied habitat which is not linked to surrounding occupied habitat is likely to remain unoccupied because animals simply cannot reach the area.

HABITAT INDICES

The habitat indices in the SWHMiST are organized by significant wildlife habitat category, as defined in the Significant Wildlife Habitat Technical Guide (OMNR 2000). These categories are:

- Seasonal Concentration Areas;
- Rare Vegetation Communities;
- Rare or Specialized Habitat;
- Habitat of Species of Conservation Concern; and
- Movement Corridors.

Each habitat index represents a unique combination of functional habitat, significant wildlife habitat category and species group. Habitat and species details are summarized at the top of each index for quick reference, including the habitat classifications according to the Ecological Land Classification (ELC) system (Lee et al. 1998), the Central Ontario FEC system (Chambers et al. 1997) and the Terrestrial and Wetland Ecosites of Northwestern Ontario (TWENO) system (Racey et al. 1996).

SEASONAL CONCENTRATION AREAS

INDEX #1: BAT HIBERNACULA

Ecoregions:	All of Ontario
Species Group:	Big Brown Bat, Tri-coloured Bat (formerly Eastern Pipistrelle)
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Bat Hibernacula (Winter Roost)
Habitat Features:	Hibernacula: abandoned mine shafts, underground foundations, caves and crevices The Little Brown Myotis (ENDANGERED), Northern Long-Eared Myotis (ENDANGERED), Eastern Small-footed Myotis (ENDANGERED) are protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that may affect these species.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Developments
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Hibernacula

The bats of Ontario are insectivores and cannot find enough food during cold weather when insect activity ceases. Some bats migrate south to avoid the food-limited winter months while others stay behind and hibernate (OMNR 2006a). Five bat species are known to hibernate in Ontario – Little Brown Myotis, Northern Long-eared Myotis, Eastern Small-footed Myotis, Big Brown Bat, and Tri-colored Bat (OMNR 2008c). Hibernating bats seek out caves or other similar structures which provide protection from freezing temperatures and predators. Caves, abandoned mines, and crevices provide safe and undisturbed hibernation sites from early autumn to mid-spring when flying insects are inactive. Bat hibernacula are relatively rare in Ontario; few sites support large numbers of wintering bats from several thousand km2 of surrounding landscape (OMNR 2000, 2008a). For example, Little Brown Myotis migrate 10 to 220 km from their summer habitat to their hibernacula (Fenton 1970). Given this level of concentration, the populations that use these hibernacula are extremely vulnerable to impacts from site alteration or destruction, disturbance, and development-related mortality.

To function as a hibernaculum, caves and other sites need to have substantial roosting areas. Active sites usually have a series of chambers linked by tunnels which are large enough for bats to fly through. Protection is provided by a restriction in the tunnel so that air exchange, temperature and humidity remain moderated and relatively constant in the roosting area (Fenton 1983). Ideally caves should be five times longer or deeper than they are wide at the openings. Overhangs and big open-mouthed caves are not suitable (OMNR 2006a). The more complex and deep the cave system is, the more likely it will function as a hibernation site. Streams and water flow help to moderate temperature and moisture inside the cave. Remote access and restricted openings to the caves help to prevent disturbance from competitive or predatory species.

Generally, active mine sites are not considered SWH.

See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

There are several factors responsible for the decline of bat populations; these factors probably vary from species to species and area to area. The most important threats to the survival of bats include destruction of hibernating bats and nursery colonies, habitat loss, and persecution (Gerson 1984).

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Hibernacula

Potential Development Effects

Site alterations which result in the loss of vegetation can reduce the ecological function of bat hibernacula. For example, the clear-cutting of forests is associated with the degradation of caves through removal of critical habitat at cave entrances, and by altering temperature, humidity and air flow within the cave (Bilecki 2003). Banding studies have shown that bat colonies forced out of their hibernacula rarely survive (Tuttle 1986). Since suitable hibernation sites are limited, the loss of any site can have significant impacts on bat populations.

Additionally, development near bat hibernacula may increase human disturbance at these sites. Human activities that have resulted in major impacts to bat colonies include cave exploration (Harvey 1975, in Mitchell and Martin 2002; Tuttle 1986), cave commercialization (USFWS 2006), cave vandalism (Tuttle 1979), and the extermination of bats by property owners over fears about rabies (Fredrickson and Thomas 1965).

Hibernating bats are very sensitive to noise, light and physical disturbances (OMNR 2008c; 2010), and even minor disturbances can have a lethal impact (OMNR 1984, 2000, 2008a). Waking during hibernation depletes the energy reserves required to survive the winter (Humphrey 1982; OMNR 1984). Juveniles are most susceptible to disturbance, as they may not accumulate sufficient food reserves prior to entering hibernation (Stebbings 1969). Individuals aroused by disturbance respond with an alarm call, triggering a chain reaction that arouses many other bats (OMNR 1984; OMNR 2000). Each human disturbance causes bats to waste 10 to 30 days of stored fat reserve (BCI Inc. n.d.) that cannot be replenished until spring (Mitchell and Martin 2002). The potential for human disturbance of hibernating bats in or near a residential, cottage or commercial development is high, both during the construction phase and afterwards.

Mitigation Options

Development will not be permitted in bat hibernacula SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of bat hibernacula SWH includes a 200m radius (OMNR 2000) around the entrance of the hibernaculum for most development types and 1000m for wind farms (OMNR 2011).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and subsequent human disturbance, in bat hibernacula SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat.

Timing is another possible mitigation option. Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally (Mitchell-Jones 2004). Short-term activities should be scheduled for when bats are absent. In Ontario, bats return to hibernacula in August when they swarm in large numbers at hibernacula entrances (OMNR 2011); hibernation occurs from September/October through April (OMNR 2008c; OMNR 2011).

Where vegetation needs to be cleared for a residential or commercial development, avoid removing protective forest cover leading to hibernacula. This cover facilitates the movement of bats to and from these sites, and maintains the site's internal temperature, air flow and humidity characteristics (Bilecki 2003). If site characteristics are altered, the ecological function of the site may be reduced or lost. Habitat disturbed during construction should be fully restored to a functional state once construction is completed (OMNR 2011).

Human activity tends to increase in areas developed for residential and commercial use. To ensure that hibernacula are not disturbed or vandalized steps will need to be taken to prevent human access to caves and other sites that support hibernacula. For example, efforts should be made to install gates and fences at the entrance to prevent people from accessing the site. Bars and other metal grids have been used successfully to protect bat caves from human disturbance (Hehn 1984). Gates must be properly designed so they do not restrict bat movement, impede air flow, alter interior temperature, or increase the vulnerability of bats to predation (Gerson 1984). In some instances, signage may be sufficient to reduce or eliminate human disturbance (Brady et al. 1983), and Gerson (1984) provided an example of text that can be used on signs. Where feasible, trails and roads that leads to hibernacula sites should be blocked or allowed to deteriorate (Brady et al. 1983).

If development is planned in groundwater recharge areas near hibernacula, hydro-geological studies should be completed to demonstrate that moisture regimes will not be affected.

MAJOR RECREATIONAL DEVELOPMENTS

Hibernacula

Potential Development Effects

Ski resorts and cave commercialization (e.g., rock climbing and spelunking, cave tours) are developments that are most likely to affect bat hibernacula.

Site alterations which result in the loss of vegetation can reduce the ecological function of bat hibernacula. For example, the clear-cutting of forests is associated with the degradation of caves through removal of critical habitat at cave entrances, and by altering temperature, humidity and air flow within the cave (Bilecki 2003). Banding studies have shown that bat colonies forced out of their hibernacula rarely survive (Tuttle 1986). Since suitable hibernation sites are limited, the loss of any site can have significant impacts on bat populations.

Additionally, recreational development near bat hibernacula will likely increase human disturbance at these sites. Human activities that have resulted in major impacts to bat colonies include cave exploration (Harvey 1975, in Mitchell and Martin 2002; Tuttle 1986), cave commercialization (USFWS 2006), and cave vandalism (Tuttle 1979).

Hibernating bats are very sensitive to noise, light and physical disturbances (OMNR 2008c; 2010), and even minor disturbances can have a lethal impact (OMNR 1984, 2000, 2008a). Waking during hibernation depletes the energy reserves required to survive the winter (Humphrey 1982; OMNR 1984). Juveniles are most susceptible to disturbance, as they may not accumulate sufficient food reserves prior to entering hibernation (Stebbings 1969). Individuals aroused by disturbance respond with an alarm call, triggering a chain reaction that arouses many other bats (OMNR 1984; OMNR 2000). Each human disturbance causes bats to waste 10 to 30 days of stored fat reserve (BCI Inc. n.d.) that cannot be replenished until spring (Mitchell and Martin 2002). During the construction phase of development, the level of human activity tends to be high, and human disturbance of wildlife often occurs.

Mitigation Options

Development will not be permitted in bat hibernacula SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of bat hibernacula SWH includes a 200m radius (OMNR 2000) around the entrance of the hibernaculum for most development types and 1000m for wind farms (OMNR 2011).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and subsequent human disturbance, in bat hibernacula SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat.

Timing is another possible mitigation option. Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally (Mitchell-Jones 2004). Short-term activities should be scheduled for when bats are absent. In Ontario, bats return to hibernacula in August when they swarm in large numbers at hibernacula entrances (OMNR 2011); hibernation occurs from September/October through April (OMNR 2008c; OMNR 2011).

Where vegetation needs to be cleared for a ski run or other recreational development, avoid removing protective forest cover leading to hibernacula. This cover facilitates the movement of bats to and from these sites, and maintains the site's internal temperature, air flow and humidity characteristics (Bilecki 2003). If site characteristics are altered, the ecological function of the site may be reduced or lost. Habitat disturbed during construction should be fully restored to a functional state once construction is completed (OMNR 2011).

Human activity tends to increase in areas of major recreational development. To ensure that hibernacula are not disturbed or vandalized, steps will need to be taken to prevent human access to caves and other sites that support hibernacula. For example, efforts should be made to install gates and fences at the entrance to prevent people from accessing the site. Bars and other metal grids have been used successfully to protect bat caves from human disturbance (Hehn 1984). Gates must be properly designed so they do not restrict bat movement, impede air flow, alter interior temperature, or increase the vulnerability of bats to predation (Gerson 1984). In some instances, signage may be sufficient to reduce or eliminate human disturbance (Brady et al. 1983), and Gerson (1984) provided an example of text that can be used on signs. Where feasible, trails and roads that lead to hibernacula sites should be blocked or allowed to deteriorate (Brady et al. 1983).

If development is planned in groundwater recharge areas near hibernacula, hydro-geological studies should be completed to demonstrate that moisture regimes will not be affected.

AGGREGATE AND MINE DEVELOPMENT

Hibernacula

Potential Development Effects

Excavation is the site alteration which presents the greatest potential for impacting bat hibernacula. If a cliff face containing a hibernaculum is excavated, there is a risk that the site will be degraded or destroyed. Vegetation removal can also reduce the ecological function of hibernacula. For example, the clear-cutting of forests is associated with the degradation of caves through removal of critical habitat at cave entrances, and by altering temperature, humidity and air flow within the cave (Bilecki 2003). Banding studies have shown that bat colonies forced out of their hibernacula rarely survive (Tuttle 1986). Since suitable hibernation sites are limited, the loss of any site can have significant impacts on bat populations.

Additionally, excavation and construction on the top margin of cliffs and associated tablelands which alter groundwater flow may affect the ecological function of hibernacula. If caves become dry as a result of changes to groundwater flow, then the site may no longer be suitable as a hibernaculum. Bats which are forced to use dried-out sites would be vulnerable to higher mortality than normal.

Aggregate and mine development near bat hibernacula will likely increase human disturbance at these sites. Hibernating bats are very sensitive to noise, light and physical disturbances (OMNR 2008c; 2010), and even minor disturbances can have a lethal impact (OMNR 1984, 2000, 2008a). Waking during hibernation depletes the energy reserves required to survive the winter (Humphrey 1982; OMNR 1984). Juveniles are most susceptible to disturbance, as they may not accumulate sufficient food reserves prior to entering hibernation (Stebbings 1969). Individuals aroused by disturbance respond with an alarm call, triggering a chain reaction that arouses many other bats (OMNR 1984; OMNR 2000). Each human disturbance causes bats to waste 10 to 30 days of stored fat reserve (BCI Inc. n.d.) that cannot be replenished until spring (Mitchell and Martin 2002).

Mitigation Options

Development will not be permitted in bat hibernacula SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of bat hibernacula SWH includes a 200m radius (OMNR 2000) around the entrance of the hibernaculum for most development types and 1000m for wind farms (OMNR 2011).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and subsequent human disturbance, in bat hibernacula SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat.

Timing is another possible mitigation option. Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally (Mitchell-Jones 2004). Short-term activities should be scheduled for when bats are absent. In Ontario, bats return to hibernacula in August when they swarm in large numbers at hibernacula entrances (OMNR 2011); hibernation occurs from September/October through April (OMNR 2008c; OMNR 2011).

Where vegetation needs to be cleared for an aggregate or mine development, avoid removing protective forest cover leading to hibernacula. This cover facilitates the movement of bats to and from these sites, and maintains the site's internal temperature, air flow and humidity characteristics (Bilecki 2003). If site characteristics are altered, the ecological function of the site may be reduced or lost. Habitat disturbed during construction should be fully restored to a functional state once construction is completed (OMNR 2011).

Aggregate and mining developments result in increased human activity at all times of the year. To ensure that hibernacula are not disturbed or vandalized, steps will need to be taken to prevent human access to caves and other sites that support hibernacula. For example, efforts should be made to install gates and fences at the entrance to prevent people from accessing the site. Bars and other metal grids have been used successfully to protect bat caves from human disturbance (Hehn 1984). Gates must be properly designed so they do not restrict bat movement, impede air flow, alter interior temperature, or increase the vulnerability of bats to predation (Gerson 1984). In some instances, signage may be sufficient to reduce or eliminate human disturbance (Brady et al. 1983), and Gerson (1984) provided an example of text that can be used on signs. Where feasible, trails and roads that lead to hibernacula sites should be blocked or allowed to deteriorate (Brady et al. 1983).

If development is planned in groundwater recharge areas near hibernacula, hydro-geological studies should be completed to demonstrate that moisture regimes will not be affected.

Once depleted, mines may become suitable hibernation sites for bats. It may be possible to rehabilitate depleted mines so that they provide suitable wintering habitat. Although there are no standard guidelines for this, examination of existing hibernacula suggests that the entrance should be relatively small to reduce flow of cold air into the hibernaculum and also to reduce access for humans and predators. Ideal sites would have variable moisture and temperature regimes and an adequate supply of oxygen.

ENERGY DEVELOPMENT

Hibernacula

Potential Development Effects: Wind Power Facilities

Wind power facilities can impact bat hibernacula directly. For example, placement of wind turbines on the top margin of a cliff risks the physical destruction of subterranean bat hibernacula. Vegetation removal can also reduce the ecological function of hibernacula. For example, the clear-cutting of forests is associated with the degradation of caves through removal of critical habitat at cave entrances, and by altering temperature, humidity and air flow within the cave (Bilecki 2003). Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006).

Banding studies have shown that bat colonies forced out of their hibernacula rarely survive (Tuttle 1986). Since suitable hibernation sites are limited, the loss of any site can have significant impacts on bat populations.

Additionally, excavation and construction on the top margin of cliffs and associated tablelands which alter groundwater flow may affect the ecological function of hibernacula. If caves become dry as a result of changes to groundwater flow, then the site may no longer be suitable as a hibernacula. Bats which are forced to use dried-out sites would be vulnerable to higher mortality than normal.

Hibernating bats are very sensitive to noise, light and physical disturbances (OMNR 2008c; 2010), and even minor disturbances can have a lethal impact (OMNR 1984, 2000, 2008a). During the construction phase of development, the level of human activity tends to be high, and human disturbance of wildlife often occurs. Operational noise and vibration may also disturb hibernating bats. At a distance of 250m, a typical wind turbine produces a sound pressure level of about 45 decibels (OMAFRA 2003); this level is more than 10 times the sound pressure level of a typical quiet rural nighttime, which is about 20 decibels (Vanderheiden 2007). Additionally, the sound from a wind turbine is intermittent and directional (NWW 2007), and the interaction of wind turbine blades with atmospheric turbulence results in a characteristic "whooshing" sound (OMAFRA 2003). Given the level and nature of turbine noise, it is likely that it would affect bats in neighbouring hibernacula, but exactly how and to what extent does not appear to be known. In addition to operational noise, wind turbines cause vibrations that travel through anything to which the turbines are attached (Better Generation Ltd. 2009). In a typical turbine installation, this vibration would be transmitted into the ground below the tower. How far and where the vibrations travel from there will likely depend on the geology of the site, e.g., bedrock below the turbine could transmit vibrations horizontally, thereby increasing the area impacted. Long-term exposure to vibrations could affect the physical integrity of hibernacula structures. No credible studies on the potential impacts of turbine noise/vibration on hibernating bats have been published (Brock Fenton, pers. com.).

When awakened by disturbance during hibernation, the energy reserves required bats to survive the winter are depleted (Humphrey 1982; OMNR 1984). Juveniles are most susceptible to disturbance, as they may not accumulate sufficient food reserves prior to entering hibernation (Stebbings 1969). Individuals aroused by disturbance respond with an alarm call, triggering a chain reaction that arouses many other bats (OMNR 1984; OMNR 2000). Each disturbance causes bats to waste 10 to 30 days of stored fat reserve (BCI Inc. n.d.).

High levels of bat activity should be expected in and around the entrances to hibernacula during the peak swarming period; in Ontario, this occurs in August (OMNR 2011). Wind turbines near these features have the potential to cause significant bat mortality due to nocturnal collisions with turbine blades and to barotrauma caused by a rapid reduction in air pressure near moving blades (Baerwald et al. 2008). Negative impacts on bats using a hibernacula will, in turn, have a negative impact on the hibernaculum itself by reducing its ecological function as a hibernacula.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 1120 m of the entrance to bat hibernacula should be avoided; this distance incorporates the SWH around the hibernaculum plus a 120 m setback of adjacent land (OMNR 2011). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the hibernaculum or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2). Given the sensitivity of bat hibernacula, however, the negative impacts associated with developing a wind power facility within this SWH (i.e., less than 1000 m from any entrance) cannot be effectively mitigated. The Mitigation Options described below apply to the 120 m setback allowance and beyond.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and subsequent human disturbance, in bat hibernacula SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat.

In addition to careful site selection, timing is another possible mitigation option. Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally (Mitchell-Jones 2004). Short-term activities within the 120 m set-back should be scheduled for when bats are absent. In Ontario, bats return to hibernacula in August when they swarm in large numbers at hibernacula entrances (OMNR 2011); hibernation occurs from September/October through April (OMNR 2008c; OMNR 2011).

If development is planned in groundwater recharge areas near hibernacula, hydro-geological studies should be completed to demonstrate that moisture regimes will not be affected. Additionally, protective forest cover leading to and surrounding hibernacula should be retained. Vegetation cover facilitates the movement of bats to and from hibernacula, and maintains the site's internal temperature, air flow and humidity characteristics (Bilecki 2003). If site characteristics are altered, the ecological function of the site may be reduced or lost. Habitat disturbed during construction should be fully restored to a functional state once construction is completed (OMNR 2011).

Consideration should also be given to shutting turbines down at night during periods of high bat activity (e.g., August) and/or when wind velocities are less than 6 km/hour. This can be accomplished by changing the cut-in speed, or altering the pitch angle of the blades to reduce rotor speed. These measures reduced bat fatalities in a southern Alberta study by 57.5% and 60.0% respectively (Baerwald et al. 2009). In Pennsylvania, decreased cut-in speeds reduced bat mortality by 53-87% with marginal annual power losses (Arnett et al. 2009).

Potential Development Effects: Solar Power Facilities

Large-scale vegetation removal, required for the installation of solar panels, will reduce or destroy the ecological function of hibernacula. For example, the clear-cutting of forests is associated with the degradation of caves through removal of critical habitat at cave entrances, and by altering temperature, humidity and air flow within the cave (Bilecki 2003).

Banding studies have shown that bat colonies forced out of their hibernacula rarely survive (Tuttle 1986). Since suitable hibernation sites are limited, the loss of any site can have significant impacts on bat populations.

Hibernating bats are also very sensitive to noise, light and physical disturbances (OMNR 2008c; 2010), and even minor disturbances can have a lethal impact (OMNR 1984, 2000, 2008a). During the construction phase of development, the level of human activity tends to be high, and human disturbance of wildlife often occurs. Regular maintenance activities may disturb hibernating bats.

When awakened by disturbance during hibernation, the energy reserves required bats to survive the winter are depleted (Humphrey 1982; OMNR 1984). Juveniles are most susceptible to disturbance, as they may not accumulate sufficient food reserves prior to entering hibernation (Stebbings 1969). Individuals aroused by disturbance respond with an alarm call, triggering a chain reaction that arouses many other bats (OMNR 1984; OMNR 2000). Each disturbance causes bats to waste 10 to 30 days of stored fat reserve (BCI Inc. n.d.).

Additionally, development that alters groundwater flow may affect the ecological function of hibernacula. If caves become dry as a result of changes to groundwater flow, then the site may no longer be suitable as a hibernacula. Bats which are forced to use dried-out sites would be vulnerable to higher mortality than normal.

A solar power development on lands adjacent to bat hibernacula habitat is unlikely to affect the hibernaculum, unless it changes the habitat's hydrologic regime.

Mitigation Options: Solar Power Facilities

Development will not be permitted in bat hibernacula SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of bat hibernacula SWH includes a 200m radius (OMNR 2000) around the entrance of the hibernaculum for most development types and 1000m for wind farms (OMNR 2011). Applicants wishing to develop within the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the hibernaculum or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. The project should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and subsequent human disturbance, in bat hibernacula SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat.

For development on lands adjacent to bat hibernacula SWH, timing is a possible mitigation option. Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally (Mitchell-Jones 2004). Short-term activities should be scheduled for when bats are absent. In Ontario, bats return to hibernacula in August when they swarm in large numbers at hibernacula entrances (OMNR 2011); hibernation occurs from September/October through April (OMNR 2008c; OMNR 2011).

If development is planned in groundwater recharge areas near hibernacula, hydro-geological studies should be completed to demonstrate that moisture regimes will not be affected. Additionally, protective forest cover leading to and surrounding hibernacula should be retained. Vegetation cover facilitates the movement of bats to and from hibernacula, and maintains the site's internal temperature, air flow and humidity characteristics (Bilecki 2003). If site characteristics are altered, the ecological function of the site may be reduced or lost. Habitat disturbed during construction should be fully restored to a functional state once construction is completed (OMNR 2011).

ROAD DEVELOPMENT

Hibernacula

Potential Development Effects

Site alterations which result in the loss of vegetation can reduce the ecological function of bat hibernacula. For example, the clear-cutting of forests is associated with the degradation of caves through removal of critical habitat at cave entrances, and by altering temperature, humidity and air flow within the cave (Bilecki 2003). Banding studies have shown that bat colonies forced out of their hibernacula rarely survive (Tuttle 1986). Since suitable hibernation sites are limited, the loss of any site can have significant impacts on bat populations.

Blasting and earth/rock moving to create road rights-of-way and road beds can directly destroy caves and crevices that are used by bats for hibernation. Additionally, roads near hibernacula will have the potential to increase human disturbance at these sites. Human activities that have resulted in major impacts to bat colonies include cave exploration (Harvey 1975, in Mitchell and Martin 2002; Tuttle 1986), cave commercialization (USFWS 2006), cave vandalism (Tuttle 1979), and the extermination of bats by property owners over fears about rabies (Fredrickson and Thomas 1965).

Hibernating bats are very sensitive to noise, light and physical disturbances (OMNR 2008c; 2010), and even minor disturbances can have a lethal impact (OMNR 1984, 2000, 2008a). Waking during hibernation depletes the energy reserves required to survive the winter (Humphrey 1982; OMNR 1984). Juveniles are most susceptible to disturbance, as they may not accumulate sufficient food reserves prior to entering hibernation (Stebbings 1969). Individuals aroused by disturbance respond with an alarm call, triggering a chain reaction that arouses many other bats (OMNR 1984; OMNR 2000). Each human disturbance causes bats to waste 10 to 30 days of stored fat reserve (BCI Inc. n.d.) that cannot be replenished until spring (Mitchell and Martin 2002). During the construction phase of development, the level of human activity tends to be high, and human disturbance of wildlife often occurs.

Mitigation Options

Development will not be permitted in bat hibernacula SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNR 2014). The area of bat hibernacula SWH includes a 200m radius (OMNR 2000) around the entrance of the hibernaculum for most development types and 1000m for wind farms (OMNR 2011).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and subsequent human disturbance, in bat hibernacula SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat.

Timing is another possible mitigation option. Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally (Mitchell-Jones 2004). Short-term activities should be scheduled for when bats are absent. In Ontario, bats return to hibernacula in August when they swarm in large numbers at hibernacula entrances (OMNR 2011); hibernation occurs from September/October through April (OMNR 2008c; OMNR 2011).

Where vegetation needs to be cleared for a road development, avoid removing protective forest cover leading to hibernacula. This cover facilitates the movement of bats to and from these sites, and maintains the site's internal temperature, air flow and humidity characteristics (Bilecki 2003). If site characteristics are altered, the ecological function of the site may be reduced or lost. Habitat disturbed during construction should be fully restored to a functional state once construction is completed (OMNR 2011).

Human activity tends to increase in areas where roads are developed. To ensure that hibernacula are not disturbed or vandalized, steps will need to be taken to prevent human access to caves and other sites that support hibernacula. For example, efforts should be made to install gates and fences at the entrance to prevent people from accessing the site. Bars and other metal grids have been used successfully to protect bat caves from human disturbance (Hehn 1984). Gates must be properly designed so they do not restrict bat movement, impede air flow, alter interior temperature, or increase the vulnerability of bats to predation (Gerson 1984). In some instances, signage may be sufficient to reduce or eliminate human disturbance (Brady et al. 1983), and Gerson (1984) provided an example of text that can be used on signs. Where feasible, trails and roads that lead to hibernacula sites should be blocked or allowed to deteriorate (Brady et al. 1983).

If development is planned in groundwater recharge areas near hibernacula, hydro-geological studies should be completed to demonstrate that moisture regimes will not be affected.

INDEX #2: DEER YARDING AND WINTER CONGREGATION AREAS

Ecoregions:	Deer Yard: 5E, 6E Deer Congregation Area: 7E, 6E
Species Group:	White-tailed Deer
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Deer Wintering Areas
Habitat Features:	Deer Yard:Generally, composed of forest stands with coniferous species and a canopy cover >60% Deer Congregation Areas: Generally, large woodlands >100ha.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

White-tailed Deer migrate seasonally between summer and winter range (Voigt et al.1997). With the onset of snow accumulation, deer start to move into wintering areas (typically in mid-December). Movement to wintering areas varies among individuals, so deer do not move 'en masse' to or from wintering areas. Deer remain in yards until snow melts in the spring (usually early April) and can move in and out of congregation areas to feed during the winter period. By aggregating during winter, deer are able to establish and maintain a network of trails leading from the cover to areas of woody browse, mast-producing trees or other food sources. In northern yards, the coniferous forest cover available provides protection from winds, hiding cover and, by holding snow on their branches; conifers effectively reduce snow depth on the ground (Hanley and Rose 1987; Voigt et al. 1997). An adequate supply of accessible woody browse is required in northern yard areas to provide food for deer throughout the winter. The concentration of deer during winter increases the chance of individuals surviving the effects of cold temperatures, deep snow, and predation (Voigt et al. 1997). The same wintering areas are used by deer and their descendants year after year (Mech and Karns 1977). The knowledge of which wintering area to migrate to is passed on from mother to offspring (Voigt et al. 1997). Individual deer northern deer yards draw animals from an area of surrounding landscape which is about 10 times larger than the yard itself (Broadfoot et al. 1996). Therefore, activities which affect wintering area functions have impacts on deer abundance beyond the site level.

For an area to function as a deer wintering area it requires the following: 1) a history of use by deer; 2) absence of barriers to migration to and from the wintering area itself; 3) suitable areas of cover, food, and adjacent natural lands.

NORTHERN DEER YARDS

MNRF actively maps deer yards following the methods in Buss et al. 1998, not all deer yards mapped by MNRF are considered SWH, therefore contact a local MNRF office to determine if deer yard habitat is significant where development is proposed. Deer habitat is separated into 3 basic habitat components: summer range, core wintering areas (Stratum I habitat); and winter staging areas (Stratum II habitat) (Buss et al. 1998). Core wintering areas define the distribution patterns of deer during mid-winter (i.e., this is where they concentrate and spend most of the winter) (Voigt et al. 1997). As deer move into and out of yards they usually stage temporarily in adjacent habitat. Deer often use staging areas located adjacent to yards for a few days or weeks prior to entering the yards depending on weather conditions (Broadfoot and Voigt 1996). These staging areas are on lands surrounding core wintering areas (adjacent lands). Staging areas in agricultural areas are usually associated with agricultural land offering food in the form of waste corn and grain, however in more forested landscapes they occur where mast producing trees are abundant. These areas are significant since they allow deer access to high quality foods before they are forced by severe weather to restrict their activities to core wintering areas. Core wintering areas are associated with conifer cover (forests composed of cedar, hemlock, spruce, white pine, etc. with > 60% canopy closure) and adjacent mixed or deciduous forest habitat (Voigt et al. 1997). It is the mixed and deciduous forest habitat which provides feed in the form of woody browse. A preponderance of browse (deciduous species and cedar) in the understory of the core feeding areas is characteristic of a quality deer yard (Voigt et al. 1997). In cottage country, the core areas of deer yards are often located along shorelines where mature conifer stands occur (Voigt and Broadfoot 1995).

SOUTHERN DEER CONGREGATION AREAS

White-tailed Deer in southern Ontario, Ecoregion 7E and the southern areas of Ecoregion 6E, are not constrained by snow depth for the use of wintering habitat. A study of woodlots used by wintering deer (Yagi and Timmerman, 2009) demonstrated that during winter, deer utilize large woodlots with the highest densities of deer found in woodlots >100ha. OMNR (2000) recognizes that in much of southern Ontario deer do not yard in the traditional sense and that deer will often congregate in large numbers in suitable forested habitat. Therefore large woodland areas in Ecoregions 7E and 6E, where snow depth and traditional deer yards do not occur, are considered as Deer Congregation areas. These large woodland areas are identified by local OMNRF Districts as Deer Winter Congregation Areas and can be considered as significant wildlife habitat when considering development proposals within or adjacent to the habitat. These large woodlots that deer use for winter congregation can be considerd simarily with development effects and mitigation as a deer yarding habitat.

POTENTIAL DEVELOPMENT EFFECTS AND MITIGATION OPTIONS

Residential and Commercial Development

Potential Development Effects

Residential developments have the potential to substantially disrupt wintering habitat functions if a significant proportion of the habitat area is affected. Because of the strong tradition deer show to using a given wintering habitat, deer will continue to migrate to the habitat after development has occurred. It will take some time (i.e., > 2 to 5 years) before deer abandon the site. This does not mean that deer will simply establish a new wintering area somewhere else (Voigt et al. 1997). As deer are displaced by development, they are forced to use poorer quality habitat and typically succumb to a variety of mortality factors from which the deer wintering area had protected them. Eventually deer numbers decline below what is needed to establish and maintain an adequate trail network through snow. At that point, mortality rates climb and eventually there is a loss of traditional use of the area. This loss of function will affect deer over an area 10 times larger than the original yard

(Broadfoot et al. 1996). Developments that affect the core area of a deer yard will have the greatest impact. In addition to reducing the amount of core yarding area and large woodlot area available, development may also restrict the movement of deer along shorelines or other critical areas, reducing access to important parts of the wintering habitat.

On adjacent lands, development may affect the movement of deer into and out of the wintering habitat, and the other activities associated with staging (see Index 39, Cervid Movement Corridor). The activities of humans and their pets (particularly dogs) can have significant effects on deer, especially during late winter when deer energy reserves are at low levels.

Single-lot development is not expected to have the same degree of impact on wintering habitat function as subdivisions. Most severe impacts are expected when the lot is located in the core areas of the yard or the centre of a large woodlot. Deer will usually abandon the impacted area, and since core areas within the yard are limited, the overall carrying capacity of the yard (the number of deer it can sustain during an average winter) will be reduced (Voigt et al. 1992). The cumulative effects of years of additional development in deer wintering habitat can grow to equal those of a subdivision development. Single-lot development on adjacent lands can affect how deer move to and from the wintering habitat. The greatest effect of adjacent land development will occur on sites where forest cover is adjacent to agricultural areas which offer deer access to high quality food. Deer commonly winter in forests among cottages along shorelines (Armstrong et al. 1983; Voigt and Broadfoot 1995). Most cottages are vacant during winter and therefore disturbance is minimal. However, many cottages are becoming year round residences and as such present a greater impact on winter deer populations. In New York (Hurst and Potter (2008) found that deer adapted to using low-density residential areas in winter that were in lowland conifer forests. These areas appeared to provide an energetic advantage for deer due to a wider variety of potential food sources.

Once new residential areas are completed, some individuals may deposit food for deer during the winter to attract them for viewing purposes and with the intention of assisting their survival. This practice often affects an animal's normal migration to a deer wintering area and congregates deer in locations they would normally not inhabit. Supplemental feeding can contribute to localized traffic hazards, damage to crops and ornamentals, and an increased potential for disease transmission. Widespread supplemental feeding can reduce the rate of normal winter mortality and contribute to deer population growth (OMNR 2006b).

Mitigation Options

Deer wintering areas are mapped by the OMNRF, and information about their location and size will be available at OMNRF District offices. Development will not be permitted in Stratum I (core) deer wintering areas unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in deer wintering SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where deer activity is lowest.

The effects of any development proposed for deer yards can be made less severe by directing activity away from core cover and core feeding areas, and areas of adjacent lands offering deer the opportunity to access abundant food supplies (i.e., agricultural crops).

It may not be possible to develop in core areas of yards measuring less than 10 km2 without causing significant effects. Development in yards larger than 10 km2 needs to be planned so that it does not disrupt any more than 15% of core area. Although one disruption of 15% of core wintering area may be acceptable in large yards, further development proposals cannot recommend an additional reduction in area of 15%. In many cases, loss of 15% of the core wintering area may not be feasible without having negative impacts. As a guideline, no more than 15% of core areas should be affected, and only in yards larger than 10 km2. Impact Assessments need to determine the amount of core area that may be developed without having negative impacts on deer wintering habitat.

Development should never isolate core areas of a yard or large woodlots from each other or block access by deer from outside the wintering habitat (see Index 39, Cervid Movement Corridor). Planting of cover species (cedar, hemlock, spruce, etc.) could expand the wintering habitat area away from the development. This should only be seen as a long-term solution since it will take 20 to 40 years for the trees to develop the required canopy characteristics (Voigt et al. 1997). (Note: it is very difficult to establish cedar and hemlock in deer yards without some form of temporary barrier since deer consume the trees before they grow out of their reach. Also, planted hemlock often does not do well even if it is not browsed by deer. Spruce is usually the best option if there are large numbers of deer in the area.)

Any development in core feeding areas needs to be planned so that the understory of the remaining woodland is left undisturbed (i.e., shrubs should not be removed). Browse along road rights-of-way adjacent to or in close proximity to feeding areas may need to be controlled (i.e., through brushing) to minimize deer-vehicle collisions.

Human activity in either core cover or core feeding areas should be restricted during the winter since any movement by deer at this time incurs a relatively large investment of energy at a time when energy conservation is critical for their survival. Nature/recreation trails traversing these habitats should be closed while deer are yarding. In some circumstances, it may be necessary to install fences to keep people out. If fencing is used, it is very important to ensure that it does not block the movement of deer to/from the habitat.

LOCAL RESIDENTIAL POPULATIONS WILL NEED TO BE EDUCATED ABOUT THE NEGATIVE EFFECTS OF FEEDING DEER DURING WINTER.

Major Recreational Development

Potential Development Effects

Golf courses and ski resorts are the types of major recreational development that are most likely to affect deer wintering areas. Golf courses can be relatively benign (provided that they do not result in major habitat destruction) as they are typically not used in winter. Nonetheless, if they are not planned properly, golf courses can affect deer yards.

Ski resorts are active during the period that deer wintering areas are being used and have greater potential to have negative effects due to human disturbance. As deer are displaced by development, they are forced to use poorer quality habitat and typically succumb to a variety of mortality factors from which the deer yard had protected them. Eventually deer numbers decline below what is needed to establish and maintain an adequate trail network through snow. At that point, mortality rates climb and eventually there is a loss of traditional use of the area. This loss of function will affect deer over an area 10 times larger than the original yard (Broadfoot et al. 1996).

Cutting swathes into a core wintering area or a large woodlot to create fairways or ski runs will result in direct habitat loss. These swathes may also act as wind tunnels and may create windthrow in residual woodlands, especially if White Cedar is the dominant tree type. This can further damage the wintering habitat area and affect its utility to deer.

Mitigation Options

Deer wintering areas are mapped by the OMNRF, and information about their location and size will be available at OMNRF District offices. Development should not be permitted in Stratum I (core) deer wintering areas unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in deer wintering SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where deer activity is lowest.

The effects of any development proposed for deer yards or large woodlots can be made less severe by directing activity away from core cover and core feeding areas, and areas of adjacent lands offering deer the opportunity to access abundant food supplies (i.e., agricultural crops). Ski runs should always be directed away from core wintering areas due to the high potential for disturbance to deer during this critical period of the year. Fencing should be installed to keep humans from entering core areas. If fencing is used, it is very important to ensure that it does not block deer movement to/from habitat. For golf course developments, fairways need to be sited along the edge of the forested portion of the wintering area as opposed to in the forest interior.

It may not be possible to develop in core areas of yards measuring less than 10 km2 without causing significant effects. Development in yards larger than 10 km2 needs to be planned so that it does not disrupt any more than 15% of core area. Although one disruption of 15% of core wintering area may be acceptable in large yards, further development proposals cannot recommend an additional reduction in area of 15%. In many cases, loss of 15% of the core wintering area may not be feasible without having negative impacts. As a guideline, no more than 15% of core areas should be affected, and only in yards larger than 10 km2. Impact Assessments need to determine the amount of core area that may be developed without having negative impacts on deer wintering habitat.

Development should never isolate core areas of a yard or large woodlots from each other or block access by deer from outside the yard (see Index 39, Cervid Movement Corridor). Planting of cover species (cedar, hemlock, spruce, etc.) could expand the core area away from the development. This should only be seen as a long-term solution since it will take 20 to 40 years for the trees to develop the required canopy characteristics (Voigt et al. 1997). (Note: it is very difficult to establish cedar and hemlock in deer yards without some form of temporary barrier since deer consume the trees before they grow out of their reach. Also, planted hemlock often does not do well even if it is not browsed by deer. Spruce is usually the best option if there are large numbers of deer in the area.)

Any development in core feeding areas needs to be planned so that the understory of the remaining woodland is left undisturbed (i.e., shrubs should not be removed). Browse along road rights-of-way adjacent to or in close proximity to feeding areas may need to be controlled (i.e., through brushing) to minimize deer-vehicle collisions.

Human activity in either core cover or core feeding areas should be restricted during the winter since any movement by deer at this time incurs a relatively large investment of energy at a time when energy conservation is critical for their survival. Nature/recreation trails traversing these habitats should be closed while deer are yarding. In some circumstances, it may be necessary to install fences to keep people out (make sure they do not block the movement of deer to/from the habitat).

Local residential populations will need to be educated about the negative effects of feeding deer during winter.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Vegetation clearing to establish pits, quarries or mines in or adjacent to deer wintering areas may result in reduced browse for wintering deer. Additionally, disturbance effects from human activity associated with aggregate and mine operations in or near deer wintering areas may discourage deer from using the habitat. As deer are displaced by development, they are forced to use poorer quality habitat and typically succumb to a variety of mortality factors from which the deer yard had protected them. Eventually deer numbers decline below what is needed to establish and maintain an adequate trail network through snow. At that point, mortality rates climb and eventually there is a loss of traditional use of the area. This loss of function will affect deer over an area 10 times larger than the original yard (Broadfoot et al. 1996).

Wintering habitat for deer could also be affected by changes in hydrology or water quality as a result of aggregate or mine development and operation.

Mitigation Options

Deer wintering areas are mapped by the OMNRF, and information about their location and size will be available at OMNRF District offices. Development will not be permitted in Stratum I (core) deer wintering areas unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in deer wintering SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where deer activity is lowest.

The effects of any development proposed for deer yards can be made less severe by directing activity away from core cover and core feeding areas, and areas of adjacent lands offering deer the opportunity to access abundant food supplies (i.e., agricultural crops). Where aggregate developments do become established in or adjacent to core feeding areas, berms and other inactive areas of the site should be planted to native species that are suitable for deer foraging. Dogwoods are a preferred woody browse species that is easy to plant and recovers from browsing, thus providing a constant source of food.

Any mining development in core feeding areas needs to be planned so that the understory of the remaining woodland is left undisturbed (i.e., shrubs should not be removed). Browse supplies could be enhanced by opening up the tree canopy (i.e., reducing it below about 60% closure) in core feeding areas (Voigt et al. 1997). The increase in browse may offset the loss of browse in the development area. Planting of browse would probably only increase overall browse supplies if the forest canopy is also opened up. Under a dense canopy, planted browse would not grow vigorously and would be quickly overbrowsed by deer (i.e., killed by browsing) (Voigt et al. 1997).

It may not be possible to develop in core areas of yards measuring less than 10 km2 without causing significant effects. Development in yards larger than 10 km2 needs to be planned so that it does not disrupt any more than 15% of core area. Although one disruption of 15% of core wintering area may be acceptable in large yards, further development proposals cannot recommend an additional reduction in area of 15%. In many cases, loss of 15% of the core wintering area may not be feasible without having negative impacts. As a guideline, no more than 15% of core areas should be affected, and only in yards larger than 10 km2. Impact Assessments need to determine the amount of core area that may be developed without having negative impacts on deer wintering habitat.

Development should never isolate core areas of a yard or large woodlots from each other or block access by deer from outside the yard (see Index 39, Cervid Movement Corridor). Planting of cover species (cedar, hemlock, spruce, etc.) could expand the core area away from the development. This should only be seen as a long-term solution since it will take 20 to 40 years for the trees to develop the required canopy characteristics (Voigt et al. 1997). (Note: it is very difficult to establish cedar and hemlock in deer yards without some form of temporary barrier since deer consume the trees before they grow out of their reach. Also, planted hemlock often does not do well even if it is not browsed by deer. Spruce is usually the best option if there are large numbers of deer in the area.)

Human activity in either core cover or core feeding areas should be restricted during the winter since any movement by deer at this time incurs a relatively large investment of energy at a time when energy conservation is critical for their survival. Nature/recreation trails traversing these habitats should be closed while deer are yarding. In some circumstances, it may be necessary to install fences to keep people out. If fencing is used, it is very important to ensure that it does not block deer movement to/from the habitat.

LOCAL RESIDENTIAL POPULATIONS WILL NEED TO BE EDUCATED ABOUT THE NEGATIVE EFFECTS OF FEEDING DEER DURING WINTER.

Energy Development

Potential Development Effects: Wind Power Facilities

Wind power development has the potential to substantially disrupt wintering habitat functions if a significant proportion of the wintering habitat area is affected. Because of the strong tradition deer show to using a given yard or large woodlot, deer will continue to migrate to the habitat after development has occurred. It will take some time (i.e., > 2 to 5 years) before deer abandon the site. This does not mean that deer will simply establish a new yard somewhere else (Voigt et al. 1997). As deer are displaced by development, they are forced to use poorer quality habitat and typically succumb to a variety of mortality factors from which the deer yard had protected them. Eventually deer numbers decline below what is needed to establish and maintain an adequate trail network through snow. At that point, mortality rates climb and eventually there is a loss of traditional use of the area. This loss of function will affect deer over an area 10 times larger than the original yard (Broadfoot et al. 1996).

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Clearing for any development would represent a direct loss of winter habitat for deer. Developments that affect the core area of the yard will have the greatest impact. In addition to reducing the amount of core yarding area available, development may also restrict the movement of deer along shorelines or other critical areas, reducing access to important parts of the yard.

On adjacent lands, development may affect the movement of deer into and out of the wintering habitat, and the other activities associated with staging (see Index 39, Cervid Movement Corridor). During the construction phase, increased human activity has the potential to significantly affect wintering deer, especially during late winter when deer energy reserves are at low levels. Human activities associated with the regular maintenance of turbines may also disturb wintering deer.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the edge of Stratum I (core) deer wintering areas should be avoided. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2). This includes making sure the development does not affect critical thermal areas or interfere with access by deer to other important parts of the yard, or to food supplies in adjacent areas (i.e., agricultural crops) (see Index 39, Cervid Movement Corridor).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on deer and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in deer wintering SWH will likely result in reduced ecological function or loss of the habitat. Human activities related to construction and regular maintenance of turbines will likely disturb yarding deer, thereby reducing the habitat's ecological function. The best mitigation option is to avoid developing in the habitat. However, if the deer yard is of sufficient size (e.g., > 10 km2), siting the development in a location as far from the core as possible and where deer activity is lowest may be a satisfactory mitigation option. Development in yards larger than 10 km2 needs to be planned so that it does not disrupt any more than 15% of core area, and maintains at least 30% of the core as conifer-dominated forest with 60% canopy closure for critical thermal cover (OMNR 2008a). Although one disruption of 15% of core wintering area may be acceptable in large yards, further development proposals cannot recommend an additional 15% reduction in area. Environmental Impact Studies need to determine the amount of core area that may be developed without having negative impacts on deer wintering habitat.

Development should never isolate core areas of a yard or large woodlot from each other or block access by deer from outside the yard (see Index 39, Cervid Movement Corridor). Planting of cover species (cedar, hemlock, spruce, etc.) could expand the core area away from the development. This should only be seen as a long-term solution since it will take 20 to 40 years for the trees to develop the required canopy characteristics (Voigt et al. 1997). (Note: it is very difficult to establish cedar and hemlock in deer yards without some form of temporary barrier since deer consume the trees before they grow out of their reach. Also, planted hemlock often does not do well even when not browsed by deer. Spruce is usually the best option if there are large numbers of deer in the area.)

Potential Development Effects: Solar Power Facilities

Vegetation clearing in deer wintering habitat has the potential to substantially disrupt habitat functions if a significant proportion of habitat area is affected. Because of the strong tradition deer show to using a wintering habitat, deer will continue to migrate to the habitat after development has occurred. It will take some time (i.e., > 2 to 5 years) before deer abandon the site. This does not mean that deer will simply establish a new yard somewhere else (Voigt et al. 1997). As deer are displaced by development, they are forced to use poorer quality habitat and typically succumb to a variety of mortality factors from which the deer yard had protected them. Eventually deer numbers decline below what is needed to establish and maintain an adequate trail network through snow. At that point, mortality rates climb and eventually there is a loss of traditional use of the area. This loss of function will affect deer over an area 10 times larger than the original yard (Broadfoot et al. 1996). Developments that affect the core area of the yard will have the greatest impact. In addition to reducing the amount of core yarding area available, development may also restrict the movement of deer along shorelines or other critical areas, reducing access to important parts of the yard.

On adjacent lands, development may affect the movement of deer into and out of the wintering habitat, and the other activities associated with staging (see Index 39, Cervid Movement Corridor). The activities of humans and can have significant effects on deer, especially during late winter when deer energy reserves are at low levels.

Most severe impacts are expected when the development affects the core areas of the yard. Deer will usually abandon the impacted core area, and since core areas within the yard are limited, the overall carrying capacity of the yard (the number of deer it can sustain during an average winter) will be reduced (Voigt et al. 1992).

Development on lands adjacent to a deer yard can affect how deer move to and from the yard. The greatest effect of adjacent land development will occur on sites where forest cover is adjacent to agricultural areas which offer deer access to high quality food.

Mitigation Options: Solar Power Facilities

Deer wintering areas are mapped by the OMNRF, and information about their location and size will be available at OMNRF District offices. Development should not be permitted in Stratum I (core) deer wintering areas unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in deer wintering SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where deer activity is lowest.

The effects of any development proposed for deer yards can be made less severe by directing activity away from core cover and core feeding areas, and areas of adjacent lands offering deer the opportunity to access abundant food supplies (i.e., agricultural crops).

It may not be possible to develop in core areas of yards measuring less than 10 km2 without causing significant effects. Development in yards larger than 10 km2 needs to be planned so that it does not disrupt any more than 15% of core area. Although one disruption of 15% of core wintering area may be acceptable in large yards, further development proposals cannot recommend an additional reduction in area of 15%. In many cases, loss of 15% of the core wintering area may not be feasible without having negative impacts. As a guideline, no more than 15% of core areas should be affected, and only in yards larger than 10 km2. Impact Assessments need to determine the amount of core area that may be developed without having negative impacts on deer wintering habitat.

Development should never isolate core areas of a yard or large woodlots from each other or block access by deer from outside the wintering area (see Index 39, Cervid Movement Corridor). Planting of cover species (cedar, hemlock, spruce, etc.) could expand the core area away from the development. This should only be seen as a long-term solution since it will take 20 to 40 years for the trees to develop the required canopy characteristics (Voigt et al. 1997). (Note: it is very difficult to establish cedar and hemlock in deer yards without some form of temporary barrier since deer consume the trees before they grow out of their reach. Also, planted hemlock often does not do well even if it is not browsed by deer. Spruce is usually the best option if there are large numbers of deer in the area.)

Any development in core feeding areas needs to be planned so that the understory of the remaining woodland is left undisturbed (i.e., shrubs should not be removed). Browse along road rights-of-way adjacent to or in close proximity to feeding areas may need to be controlled (i.e., through brushing) to minimize deer-vehicle collisions.

Human activity in either core cover or core feeding areas should be restricted during the winter since any movement by deer at this time incurs a relatively large investment of energy at a time when energy conservation is critical for their survival. If possible, schedule regular maintenance activities to occur when deer are not using the yard. In some circumstances, it may be necessary to install fences to keep people out. If fencing is used, it is very important to ensure that it does not block deer movement to/from the habitat.

WORKERS SHOULD BE EDUCATED ABOUT THE NEGATIVE EFFECTS OF FEEDING DEER DURING WINTER.

Road Development

Potential Development Effects

Any site alteration which reduces the area of forest cover or the food supply available to deer within the wintering habitat will have negative impacts on deer. The greatest impacts are anticipated in situations where core and core feeding areas are affected. Site alterations, such as road construction, which isolate core areas from one another and/or from core feeding areas, will result in deer abandoning the isolated habitat patch.

Construction and site alterations on lands adjacent to the yard will have their greatest effect if they disrupt access by deer. Deer are often killed on roads adjacent to yards during winter. This not only affects deer numbers but also presents a serious human safety hazard.

New roads may result in increased human disturbance in nearby/adjacent deer yards (e.g., snow machines, ATVs, ski trails). As deer are displaced by development, they are forced to use poorer quality habitat and typically succumb to a variety of mortality factors from which the deer yard had protected them. Eventually deer numbers decline below what is needed to establish and maintain an adequate trail network through snow. At that point, mortality rates climb and eventually there is a loss of traditional use of the area. This loss of function will affect deer over an area 10 times larger than the original yard (Broadfoot et al. 1996).

Mitigation Options

Deer wintering areas are mapped by the OMNRF, and information about their location and size will be available at OMNRF District offices. Development will not be permitted in Stratum I (core) deer wintering areas unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in deer wintering SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where deer activity is lowest.

The effects of any development proposed for deer yards can be made less severe by directing activity away from core cover and core feeding areas, and areas of adjacent lands offering deer the opportunity to access abundant food supplies (i.e., agricultural crops).

Construction of any new road through a deer wintering area will increase deer/vehicle collisions. Planning to develop roads through this type of habitat puts both deer and human safety at risk. Road development should be directed away from core cover and core feeding areas and areas of adjacent lands offering deer the opportunity to access abundant food supplies (i.e., agricultural crops). Road development should never isolate the core areas of a yard from eachother or block access by deer from outside the yard (see Index 39, Cervid Movement Corridor).

Any road built within or adjacent to wintering habitat will need to have Deer-crossing signs erected to warn motorists of the high risk of striking a deer. Browse along road rights-of-way adjacent to or in close proximity to wintering and feeding areas may need to be controlled (i.e., through brushing) to minimize deer-vehicle collisions.

In some areas, roadside wildlife warning reflectors have been erected to reduce the incidence of deer-vehicle collisions. D'Angelo et al. (2006) found that these were ineffective.

Road development tends to increase human activity in an area. Human activity in either core cover or core feeding areas should be restricted during the winter since any movement by deer at this time incurs a relatively large investment of energy at a time when energy conservation is critical for their survival. Nature/recreation trails traversing these habitats should be closed while deer are yarding. In some circumstances, it may be necessary to install fences to keep people out. If fencing is used, it is very important to ensure that it does not block deer movement to/from the habitat.

Local residential populations will need to be educated about the negative effects of feeding deer during winter.

INDEX #3: MAST-PRODUCING AREAS

Ecoregions:	5E
Exception:	6E-14
Species Group:	Black Bear, White-Tailed Deer, Wild Turkey, Ruffed Grouse
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Mast-producing Areas
Habitat Features:	Woodlots >50% of large diameter mast-producing tree species

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Mast is a generic term for the edible seeds and fruit produced by trees and shrubs. Hard mast species, like oak, beech, butternut, hazel and hickory, have a hard-shelled fruit (e.g., acorns, hazelnuts). Soft mast species, like birch, mountain ash, ironwood, pin cherry and flowering dogwood have a soft fruit or flower (e.g., flowers, seeds, catkins, berries). In Ontario, important mast-producing trees and shrub species include American beech, oak, hickory, basswood, black cherry, ironwood, butternut, black walnut, honey locust and American chestnut (Landowner Resource Centre 1999).

Over 75 species of birds and mammals within Ontario's Great Lakes-St. Lawrence forest region alone rely on mast, and abundant supplies can enhance their survival and productivity (OMNR 2000). In summer and fall, forests containing numerous large beech and red oak trees supply the energy-rich beechnuts and acorns preferred by Black Bears. White-tailed Deer may also rely on supplies of nuts to build fat reserves to carry them through the winter. Berry-producing shrubs and other soft-mast plants provide food for a wide variety of mammals and birds (OMNR 2000), including the Ruffed Grouse, which is the most abundant grouse in the province and a popular game species.

See the Appendix of species descriptions for habitat details about the members of this species group.

POTENTIAL DEVELOPMENT EFFECTS AND MITIGATION OPTIONS

Residential and Commercial Development

Potential Development Effects

Development has the potential to eliminate some unique feeding areas or make them inaccessible. For Black Bears, this is particularly true of open areas used during early spring since they tend to be small (< 0.5 ha). Residential development in or near large berry patches of forests producing significant mast crops may bring bears into conflict with humans. Bears may continue to use the berry patch and may also start to forage around homes and businesses looking for edible refuse. Nuisance bear complaints may become frequent. Development on adjacent lands may result in the same nuisance bear effect since bears travel considerable distances to reach feeding areas (OMNR 2007a).

Roads, buildings, and construction of other structures may destroy the function of a unique feeding area. While roads in the development are likely to increase mortality for deer (due to collisions), bears tend to avoid areas within 100 m of major roads (Howe et al. 2007). If significant food resources remain distributed around the structures, bears will continue to come to the site. If the structures are not inhabited when bears are using the unique feeding area, the effects may be minor. Any time humans and bears are brought into contact; bears will be deterred from returning to the site. If this occurs, a significant food source for a local bear population will have been lost resulting in the reduction of the area's carrying capacity for bears (Howe et al. 2007). Fragmentation of habitat by development may also reduce carrying capacity for bears and this has the potential to cause local extirpations in small or isolated populations (Howe et al. 2007). A reduced food supply will force bears to seek alternate food sources, which again may result in conflicts with humans. In some cases, bears become habituated to humans and these bears may become destructive or dangerous (OMNR 2007a).

Forest clearing and excavation can result in the permanent loss of unique feeding areas like forest openings, blueberry patches, and oak and beech stands, or reduce overall carrying capacity (Howe et al. 2007). Fire suppression designed to protect populated areas can negatively affect bear, deer and grouse, as burn-overs tend to be rich in soft mast (e.g., berry-producing fruits such as blueberries and raspberries). Game birds such as Ruffed Grouse benefit from the openings created by fire in bush areas as they depend upon early-successional stages of woody vegetation.

Deer are quite adaptable when it comes to habitat, so development affecting mast production may be less of an issue for this species than for others. Clearing of vegetation may have beneficial downstream impacts for deer, as they like edge habitat and it may increase the production of soft mass. Residential development may actually result in newly available mast (e.g., through the planting of fruit trees and canes).

Mitigation Options

Development will not be permitted in significant mast-producing habitat unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes the forested ELC ecosite that contains the mast-producing vegetation.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2000).

Clearing for development in mast-producing SWH will result in the physical destruction of the affected habitat. Development-related human activities, both during construction and after completion, will likely disturb wildlife using the habitat, thereby reducing the habitat's ecological function. The best mitigation option is to avoid developing in the habitat. However, if the mast-producing woodland is large (e.g., 50 ha), it may be possible to site a residential or commercial development at the edge without negatively impacting the feature or its ecological function. It is also important to site the development so that it does not interfere with wildlife access to and from the mast-producing vegetation within the woodland.

Human activity tends to increase in areas of residential and commercial development. Increased human activity can lead to human/wildlife conflicts. Although a development proposal may indicate that it impacts very little of the unique feeding area, or that it is located only on adjacent lands, some nuisance bear problems may occur. The magnitude of the problem will depend on the density of bears in the area, the attractiveness of the unique feeding area to bears, and the availability of other similar feeding sites.

Developments in or adjacent to unique bear feeding areas will have to have plans for management of human refuse. Garbage pails and waste transfer sites are spots that attract bears. Efficient garbage collection and storage is an important consideration in bear country (OMNR 2007a). An education program to teach residents how to live with bears may be useful.

Alternate food sources may be created in some cases, by planting berries or mast trees, or by planting lure crops such as corn in an attempt to draw bears away from human habitations. Clearing small patches in woodlands would create openings that would grow up in raspberries and possibly other soft-mast species. This would have to be done well away from the development, as it may simply attract more bears to the area. Also, mast trees take several years to grow to the point where they are likely to produce mast. Good success in establishing oak forests has been experienced in southern Ontario by planting acorns. This has produced 3-m tall oak trees within 10 years, although it will take some time before mast is produced. Nursery trees that have been grown using the root production method (RPM®) grow rapidly and oak trees may produce acorns by the time they are 15 years old instead of the normal 35 or more years (EarthGen International Inc. 2009).

In the case of deer and grouse, clearing for residential development could be done selectively, so mast-producing trees (e.g., oak) are spared. Clearing may be beneficial as both deer and grouse are reliant on early successional forests, and they frequent edge habitat. Grouse, however, may be adversely affected by development due to increased predation by pets, human disturbance, and increased hunting pressure. As with bear, alternate food sources may be created by planting berries or mast trees or creating forest openings. Mast such as wild grape may benefit as new edge habitat and shrubby areas are created.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Mast-producing areas may be affected by golf courses and ski resorts. The greatest impact is most likely to be due to direct habitat loss as a result of developing golf fairways and ski runs.

Development has the potential to eliminate some unique feeding areas or make them inaccessible. For Black Bears, this is particularly true of open areas used during early spring since they tend to be small (< 0.5 ha).

Fragmentation of habitat by development may also reduce carrying capacity for bears and this has the potential to cause local extirpations in small or isolated populations (Howe et al. 2007). A reduced food supply will force bears to seek alternate food sources.

Forest clearing and excavation can result in the permanent loss of unique feeding areas like forest openings, blueberry patches, and oak and beech stands, or reduce overall carrying capacity (Howe et al. 2007). Fire suppression designed to protect property can negatively affect bear, deer and grouse, as burn-overs tend to be rich in soft mast (e.g., berry-producing fruits such as blueberries and raspberries). Game birds such as Ruffed Grouse benefit from the openings created by fire in bush areas as they depend upon early-successional stages of woody vegetation.

Deer are quite adaptable when it comes to habitat, so development affecting mast production may be less of an issue for this species than for others. Clearing of vegetation may have beneficial downstream impacts for deer, as they like edge habitat and it may increase the production of soft mass. Recreational development may actually result in newly available mast (e.g., through the planting of fruit trees and canes).

Mitigation Options

Development will not be permitted in significant mast-producing habitat unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes the forested ELC ecosite that contains the mast-producing vegetation.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in mast-producing SWH will result in the physical destruction of the affected habitat. Development-related human activities, both during construction and after completion, will likely disturb wildlife using the habitat, thereby reducing the habitat's ecological function. The best mitigation option is to avoid developing in the habitat. However, if the mast-producing woodland is large (e.g., 50 ha), it may be possible to site a golf course or ski run at the edge without negatively impacting the feature or its ecological function. It is also important to site the development so that it does not interfere with wildlife access to and from the mast-producing vegetation within the woodland.

Human activity tends to increase in areas of major recreational development. Increased human activity can lead to human/wildlife conflicts. Although a development proposal may indicate that it impacts very little of the unique feeding area, or that it is located only on adjacent lands, some nuisance bear problems may occur. The magnitude of the problem will depend on the density of bears in the area, the attractiveness of the unique feeding area to bears, and the availability of other similar feeding sites. This is not likely to be an issue for ski resorts, as bears will be hibernating during the peak human activity periods.

For golf courses and ski hills, it may be possible to retain significant feeding areas within the golf course and ski hill design.

Golf course developments in or adjacent to unique bear feeding areas will have to have plans for management of human refuse. Garbage pails and waste transfer sites are spots that attract bears. Efficient garbage collection and storage is an important consideration in bear country (OMNR 2007a). This is not likely to be an issue for ski resorts, as bears will be hibernating during the peak human activity periods.

Alternate food sources may be created in some cases, by planting berries or mast trees, or by planting lure crops such as corn in an attempt to draw bears away from recreational areas. Clearing small patches in woodlands would create openings that would grow up in raspberries and possibly other soft-mast species. This would have to be done well away from the development, as it may simply attract more bears to the area. Also, mast trees take several years to grow to the point where they are likely to produce mast. Good success in establishing oak forests has been experienced in southern Ontario by planting acorns. This has produced 3-m tall oak trees within 10 years, although it will take some time before mast is produced. Nursery trees that have been grown using the root production method (RPM®) grow rapidly and oak trees may produce acorns by the time they are 15 years old instead of the normal 35 or more years (EarthGen International Inc. 2009).

In the case of deer and grouse, clearing for recreational development could be done selectively, so mast-producing trees (e.g., oak) are spared. Clearing may be beneficial as both deer and grouse are reliant on early successional forests, and they frequent edge habitat. Grouse, however, may be adversely affected by development due to increased predation by pets, human disturbance, and increased hunting pressure. As with bear, alternate food sources may be created by planting berries or mast trees or creating forest openings. Mast such as wild grape may benefit as new edge habitat and shrubby areas are created.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Quarry excavation or mining could result in the direct loss of significant foraging areas for bears. For Black Bears, this is particularly true for small open areas (<0.5 ha) that are used for foraging in spring. Fragmentation of habitat by mines or quarries may also reduce carrying capacity for bears and this has the potential to cause local extirpations in small or isolated populations (Howe et al. 2007).

Forest clearing and excavation can result in the permanent loss of unique feeding areas like forest openings, blueberry patches, and oak and beech stands, or reduce overall carrying capacity (Howe et al. 2007).

Deer are quite adaptable when it comes to habitat, so development affecting mast production may be less of an issue for this species than for others. Clearing of vegetation may have beneficial downstream impacts for deer, as they like edge habitat and it may increase the production of soft mass.

Mitigation Options

Development will not be permitted in significant mast-producing habitat unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes the forested ELC ecosite that contains the mast-producing vegetation.

Mast-producing areas are most likely to be affected by stone quarries and mines in this development category.

Clearing for development in mast-producing SWH will result in the physical destruction of the affected habitat. Development-related human activities, both during construction and after completion, will likely disturb wildlife using the habitat, thereby reducing the habitat's ecological function. The best mitigation option is to avoid developing in the habitat.

Where complete avoidance is not possible, thought needs to be given to creating additional habitat adjacent to the site. This habitat should be located such that it won't be avoided by wildlife because of disturbance from the extraction or mining activities. Additional foraging habitat could be created by making openings in closed-canopy forests and by planting mast-producing shrubs and trees. Pit rehabilitation plans can incorporate planting of mast-producing trees. Good success in establishing oak forests has been experienced in southern Ontario by planting acorns. This has produced 3-m tall oak trees within 10 years, although it will take some time before mast is produced. Nursery trees that have been grown using the root production method (RPM®) grow rapidly and oak trees may produce acorns by the time they are 15 years old instead of the normal 35 or more years (EarthGen International Inc. 2009).

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Wind power development has the potential to eliminate some unique feeding areas or make them inaccessible. Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Clearing for any development would represent a direct loss of mast-producing vegetation.

Fragmentation of habitat by development may also reduce its carrying capacity for Black Bears which has the potential to cause local extirpations in small or isolated populations (Howe et al. 2007). A reduced food supply will force bears to seek alternate food sources.

Deer are quite adaptable when it comes to habitat, so development affecting mast production may be less an issue for this species than for others. Clearing of vegetation may have beneficial downstream impacts for deer, as clearing creates edge habitat and may increase the production of soft mast.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of significant mast-producing habitat should be avoided. The SWH includes the forested ELC ecosite that contains the mast-producing vegetation, so this distance is measured from the edge of the ecosite. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on mast-producing habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in mast-producing SWH will result in the physical destruction of the affected habitat. Human activities related to construction and regular maintenance of turbines will likely disturb wildlife using the habitat, thereby reducing the habitat's ecological function. The best mitigation option is to avoid developing in the habitat. However, if the mast-producing woodland is large (e.g., 50 ha), it may be possible to place a turbine at the edge without negatively impacting the feature or its ecological function. It is also important to site the development so that it does not interfere with wildlife access to and from the mast-producing vegetation within the woodland.

If significant mast-producing areas will be affected by development, thought needs to be given to creating additional habitat adjacent to the existing mast-producing woodland. Additional foraging habitat could be created by making openings in closed-canopy forests and by planting mast-producing shrubs and trees. Good success in establishing oak forests has been experienced in southern Ontario by planting acorns. This has produced 3 m tall oak trees within 10 years, although it will take some time before mast is produced. Nursery trees that have been grown using the root production method (RPM®) grow rapidly and oak trees may produce acorns by the time they are 15 years old instead of the normal 35 or more years (EarthGen International Inc. 2009).

Potential Development Effects: Solar Power Facilities

Development has the potential to eliminate some unique feeding areas or make them inaccessible, and to bring wildlife into conflict with humans. For Black Bears, this is particularly true of open areas used during early spring since they tend to be small (< 0.5 ha).

Vegetation clearing for the installation of solar panels, access roads and other project components will destroy affected habitat, and likely reduce or destroy the ecological function of remaining habitat through effects relating to human activity in and around the project location (e.g., disturbance, mortality, loss of access due to avoidance of the development). For example, roads in the development are likely to increase mortality for deer (due to collisions), whereas bears tend to avoid areas within 100 m of major roads (Howe et al. 2007). If significant food resources remain distributed around the structures, bears will continue to come to the site. Any time humans and bears are brought into contact; bears will be deterred from returning to the site. If this occurs, a significant food source for a local bear population will have been lost resulting in the reduction of the area's carrying capacity for bears (Howe et al. 2007). Fragmentation of habitat by development may also reduce carrying capacity for bears and this has the potential to cause local extirpations in small or isolated populations (Howe et al. 2007). A reduced food supply will force bears to seek alternate food sources, which again may result in conflicts with humans. In some cases, bears become habituated to humans and these bears may become destructive or dangerous (OMNR 2007a).

Forest clearing and excavation can result in the permanent loss of unique feeding areas like forest openings, blueberry patches, and oak and beech stands, or reduce overall carrying capacity (Howe et al. 2007). Fire suppression designed to protect developed areas can negatively affect bear, deer and grouse, as burn-overs tend to be rich in soft mast (e.g., berry-producing fruits such as blueberries and raspberries). Game birds such as Ruffed Grouse benefit from the openings created by fire in bush areas as they depend upon early-successional stages of woody vegetation.

Deer are quite adaptable when it comes to habitat, so development affecting mast production may be less of an issue for this species than for others. Clearing of vegetation may have beneficial downstream impacts for deer, as they like edge habitat and it may increase the production of soft mass.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of mast-producing SWH should be avoided. The SWH includes the forested ELC ecosite that contains the mast-producing vegetation, so this distance is measured from the edge of the ecosite. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in mast-producing SWH will result in the physical destruction of habitat under the development footprint. Development-related human activities, both during construction and after completion, will likely disturb wildlife using the habitat, thereby reducing the ecological function of retained habitat. The best mitigation option is to avoid developing in the habitat.

Where complete avoidance is not possible, and the mast-producing woodland is large (e.g., 50 ha), minimizing the amount of affected habitat may be a satisfactory mitigation. For example, make the development footprint where it affects the habitat as small as possible, and site it at the edge of the ecosite that contains the mast-producing vegetation. Select a location where mast-producing vegetation is least dense. It is also important to site the development so that it does not interfere with wildlife access to and from the mast-producing vegetation within the woodland.

Human activity tends to increase in developed areas. Increased human activity can lead to human/wildlife conflicts. Although a development proposal may indicate that it impacts very little of the unique feeding area, or that it is located only on adjacent lands, some nuisance bear problems may occur. The magnitude of the problem will depend on the density of bears in the area, the attractiveness of the unique feeding area to bears, and the availability of other similar feeding sites.

Developments in or adjacent to unique bear feeding areas will have to have plans for management of human refuse. Garbage pails and waste transfer sites are spots that attract bears. Efficient garbage collection and storage is an important consideration in bear country (OMNR 2007a). An education program to teach workers how to co-exist with bears may be useful.

Alternate food sources may be created in some cases, by planting berries or mast trees, or by planting lure crops such as corn in an attempt to draw bears away from the development. Clearing small patches in woodlands would create openings that would grow up in raspberries and possibly other soft-mast species. This would have to be done well away from the development, as it may simply attract more bears to the area. Also, mast trees take several years to grow to the point where they are likely to produce mast. Good success in establishing oak forests has been experienced in southern Ontario by planting acorns. This has produced 3-m tall oak trees within 10 years, although it will take some time before mast is produced. Nursery trees that have been grown using the root production method (RPM®) grow rapidly and oak trees may produce acorns by the time they are 15 years old instead of the normal 35 or more years (EarthGen International Inc. 2009).

In the case of deer and grouse, clearing may be beneficial; both species are reliant on early successional forests, and they frequent edge habitat. Grouse, however, may be adversely affected by solar power development due to increased human disturbance at the project site. As with bear, alternate food sources may be created by planting berries or mast trees or creating forest openings away from the project site. Mast such as wild grape may benefit as new edge habitat and shrubby areas are created.

ROAD DEVELOPMENT

Potential Development Effects

Roads may destroy the function of a unique feeding area. While roads are likely to increase mortality for deer (due to collisions), bears tend to avoid areas within 100 m of major roads (Howe et al. 2007). Fragmentation of habitat by roads may also reduce carrying capacity for bears and this has the potential to cause local extirpations in small or isolated populations (Howe et al. 2007).

Forest clearing and excavation can result in the permanent loss of unique feeding areas like forest openings, blueberry patches, and oak and beech stands, or reduce overall carrying capacity (Howe et al. 2007).

Roads can act as a barrier to movement of bears among key habitats.

Mitigation Options

Development will not be permitted in significant mast-producing habitat unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes the forested ELC ecosite that contains the mast-producing vegetation.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in mast-producing SWH will result in the physical destruction of the affected habitat. Human activities related to construction and use of the road will likely disturb wildlife using the habitat, thereby reducing the habitat's ecological function. The best mitigation option is to avoid developing in the habitat. However, if the mast-producing woodland is large (e.g., 50 ha), it may be possible to site the development along an edge without negatively impacting the feature or its ecological function. It is also important to site the development so that it does not interfere with wildlife access to and from the mast-producing vegetation within the woodland.

Road development should not isolate important feeding areas or bisect key movement corridors. This is particularly true for Black Bears, but also for White-tailed Deer if roads are situated where they intercept corridors between key foraging areas and summer and winter habitat.

There may be occasions when a road cannot be routed to avoid significant mast-producing areas. In these cases, there may not be many options for mitigation. It is not recommended that additional foraging habitat be created near the road. This may result in attraction of deer to the area and increased incidence of deer-vehicle collisions. Bears are likely to avoid roads and therefore establishment of food plots near a road would probably be ineffective, and it is undesirable to attract bears to roadsides.

Browse along road rights-of-way adjacent to or in close proximity to feeding areas may need to be controlled (i.e., through brushing) to minimize deer-vehicle collisions. Signage could also be provided to warn motorists that the road is frequently crossed by deer.

INDEX #4: COLONIALLY NESTING BIRD BREEDING HABITAT (BANK/CLIFF)

Ecoregions:	All of Ontario
Species Group:	Colonial Birds: Cliff Swallow, Northern Rough-winged Swallow
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Colonial Nesting Bird Habitat
Habitat Features:	Eroding banks, sandy hills, pits, steep slopes, rock faces or piles The Bank Swallow (THREATENED) are protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that may affect these species.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Cliff Swallows originally inhabited open canyons, escarpments, and river valleys that offered a vertical cliff face with a horizontal overhang for nest attachment. Some still nest in these habitats, but others have adapted to nesting on man-made structures such as buildings and under bridges. Cliff Swallows prefer open areas near water, where insects and mud are plentiful (Terres 1980). Agricultural and riparian areas are usually nearby. Nests are typically bottle- or flask-shaped mud structures with a narrow entrance on the side, but they can also be simple mud cups similar to the nests of Barn Swallows. Nests are placed at junctures of vertical wall and horizontal overhang, and may be anywhere from 1.5 m to ≥10 m above ground or water surface. On cliff sites, the distribution of overhangs usually dictates where nests can be placed and accounts for irregular distribution of nests within colony. Successive arrivals often build nests directly below the first tier of nests, offsetting nests slightly in honeycombed pattern. Cliff sites vary substantially in height, but are always open and free of vegetation, allowing birds an unobstructed flight path to and from nests. Colonies can number from just a few nests to 1,000 or more, and typically occur on sites protected from ground predators. Cliff Swallows apparently have specific nesting requirements that are as yet unknown, as their distribution is patchy, and there are many areas that appear to be suitable habitat that host no Cliff Swallows (Terres 1980; Brown and Brown 1995). The absence of colonies from some cliffs may reflect substrate composition; birds apparently avoid nesting on unstable sandstone which crumbles frequently (Brown and Brown 1995). Cliffs composed of limestone, dolostone and/or sandstone are most prevalent along the Niagara Escarpment, from Manitoulin Island to near Niagara-on-the-Lake. Granite cliffs are more widespread in the province, but metamorphic/granitic cliffs are only found on the Frontenac axis in Site Region 6E (OMNR 2000).

Northern Rough-winged Swallows historically nested in earthen banks, but now have adapted to using artificial sites such as sand and gravel pits, and pipes under concrete bridges (Cadman et al. 2007). The species does not ordinarily excavate its own nest burrows, being dependent upon burrows constructed previously by other Swallows or Belted Kingfishers, or upon other cavities. Northern Rough-winged Swallows can be found nesting in numbers at the periphery of active Swallow colonies.

See the Appendix of species descriptions for habitat details about the members of this species group.

POTENTIAL DEVELOPMENT EFFECTS AND MITIGATION OPTIONS

Cliff Swallows are generally quite tolerant of human activity in the general vicinity of the colony (Brown and Brown 1995; Garrison 1998, 1999).

On the whole, the impact of humans on Cliff Swallows appears to have been generally positive; construction of bridges, culverts, buildings, etc. have provided additional habitat for these birds (Brown and Brown 1995), while their natural habitat (vertical cliffs) is not often the target of development. Rough-winged Swallows have also benefited from human development activities; between 30 and 60% of nests in Canada are thought to be located in human-altered habitats, e.g., road cuts, gravel pits, buildings, walls, etc. (Erskine 1979). Habitat destruction and water pollution may affect the species. Local breeding populations may benefit greatly from proper management of quarries or cliff sites and placement of artificial nest burrows (De Jong 1996).

A wide variety of land uses occur around Swallow colonies including hydroelectric power generation, irrigation water conveyance, water level regulation, recreational boating, agriculture, vehicular and pedestrian traffic, and livestock grazing. Adjacent land uses that do not alter the integrity of naturally eroding nesting banks, allow bank erosion to occur (outside the breeding season), and do not negatively impact insect food resources are unlikely to have substantive adverse impacts to Swallows (Garrison 1998). However, any land use has the potential for adverse effects if it causes fluctuating water levels and increased erosion during the nesting period whereby banks with active colonies collapse.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Housing and cottage development along watercourses can destroy Swallow nests through soil compaction and erosion during construction, and through bank armoring/stabilization projects that harden surfaces and reduce slope. The use of pesticides and removal of aquatic and riparian vegetation in such neighbourhoods can also have a negative impact on swallows by reducing the abundance of insect prey.

Major upstream developments have the potential to change the hydrology of the stream in the vicinity of a nesting colony. There may be higher and more frequent peak flows in the stream and base flows may be lower. This could change the erosion rate of the bank and in extreme cases cause either slumping or stabilization and re-vegetation of the bank. Higher peak flows could also result in flooding of the colony.

Mitigation Options

Development will not be permitted within 50 m of the most peripheral nests in a significant swallow colony unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Shoreline alterations in bank or cliff swallow nesting SWH may damage or destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where nest density is lowest.

Schedule construction activities to occur when the birds are not using the habitat.

Heavy equipment used during the construction process should always be kept away from the edge of embankments. Natural erosion processes should be encouraged; the installation of rip-rap, armour-stone and other hard materials to the bank surface need to be minimized where possible. Riparian and aquatic vegetation along watercourses need to be maintained to provide habitat and food for forage insect species.

Appropriate stormwater management practices should be implemented so that there are no significant changes in the hydrology of the stream along which the colony is situated.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf course development could affect colonies if cart paths are situated over or adjacent to Swallow colonies. Colonies could also be affected if the stream banks were hardened with rip-rap, if there were changes in the hydrology of the stream, or if heavy equipment compacted soils in the vicinity of the colony.

Ski resort development in or adjacent to a cliff swallow colony could adversely affect the habitat and its ecological function during construction. Additionally, summer rock climbing recreation at ski resorts could physically damage this habitat and disturb nesting birds.

Mitigation Options

Development will not be permitted within 50 m of the most peripheral nests in a significant swallow colony unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Site alteration in bank or cliff swallow nesting SWH may damage or destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where nest density is lowest.

Cart paths on golf courses should not cross streams in the immediate vicinity of a Swallow colony. Cart paths should generally be built away from watercourse bends and cutbanks as these are the locations most likely to support swallow colonies.

Schedule construction activities to occur when the birds are not using the habitat.

Heavy equipment used during the construction process should always be kept away from the edge of embankments. Natural erosion processes need to be maintained; the installation of rip-rap and other hard materials to the bank surface or other efforts to increase bank stability need to be minimized where possible. Riparian and aquatic vegetation along watercourses should be maintained to provide habitat and food for forage insect species.

Appropriate stormwater management practices should be implemented so that there are no significant changes in the hydrology of the stream along which the colony is situated.

Cliff Swallow colonies should be retained when planning ski resorts, and damage to them avoided during the construction process.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

No potential impacts have been identified for this development category (Swallow Colony SWH does not include a licensed/permitted Mineral Aggregate Operation).

Mitigation Options

Although no potential impacts have been identified for this development category, pits and quarries may provide temporary habitats for Northern Rough-winged Swallows and Cliff Swallows during operation of the facility and after rehabilitation. In the case of pits, leaving steep earthen banks after the pit is closed has the potential to provide habitat for Swallows. This will be temporary, and habitat may only be suitable for 2-3 years until banks begin to slump and become unfavourable.

For pits where Swallow colonies have become established, steep banks should always be retained until they are no longer suitable for swallows, provided that this is not a safety hazard. In essence, the normal rehabilitation of the pit should be postponed in the vicinity of the colony until it is abandoned.

In worked-out quarries, there may be opportunities to create permanent habitat for Cliff Swallows if this species has become established. The area supporting the colony should be retained as cliff instead of being rehabilitated to more gentle slopes provided that this is not a safely issue.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Wind energy projects have the potential to adversely affect birds through direct fatalities, disturbance, and habitat loss (Kingsley and Whittam 2005, Environment Canada 2007a). With a few important exceptions (e.g., raptors in California), avian fatalities at wind power facilities tend to be low relative to other anthropogenic mortality factors (Kingsley and Whittam 2005). Collisions occur mainly at sites where there are unusual concentrations of birds (e.g., migration corridors) and wind turbines, or where the behaviour of birds puts them at risk (e.g., aerial courtship displaying) (Arcus Renewable Energy Consulting Ltd. 2007). Greater adverse effects from wind power facility development result from disturbance and habitat loss (Kingsley and Whittam 2005).

Any development along the top edges of Swallow nesting embankments or bluffs, such as the construction of wind turbines, has the potential to damage nesting burrows through compaction or erosion.

Operational turbines may not disturb nesting Swallows. James (2008) reported that thousands of pairs of Swallows nested near the Erie Shore Wind Farm on Lake Erie without being disturbed or any mortality occurring. Due to the steepness of the slopes, he could not accurately determine where nests were located, but some were within 150 m of active turbines.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 170 m of active swallow colonies should be avoided; this distance incorporates the SWH around the colony plus a 120 m setback of adjacent land. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Siting turbines far enough back from the nesting embankment or cliff edge where soils are sufficiently stable to prevent any potential physical damage to nesting colonies may be a satisfactory mitigation option. Additionally, turbines should be located away from areas of high bird activity and not between the colony and preferred foraging areas.

Potential Development Effects: Solar Power Facilities

The installation of solar panels on the margins of bank/cliff habitat has the potential to damage or destroy Swallow nesting habitat. Soil compaction and erosion during construction can collapse existing burrows; bank armoring/stabilization projects that harden surfaces and reduce slope will make banks unsuitable for burrowing and increase predator access.

Development on upstream lands adjacent to shoreline bank/cliff habitat has the potential to change the hydrology in the vicinity of a nesting colony. Runoff from the project may cause higher and more frequent peak flows in the stream. This could change the erosion rate of the bank and in extreme cases cause either slumping or stabilization and re-vegetation of the bank. Higher peak flows could also result in flooding of the colony.

Solar power development on the margins above a cliff swallow colony could adversely affect the habitat and its ecological function during construction (disturbance, damage from heavy machinery).

Vegetation clearing adjacent to cliff nesting habitat for the installation of solar panels, access roads and other project components may have a negative impact on swallows by reducing the abundance of insect prey. The use of pesticides to control vegetation growth under the footprint of the project may also depress insect abundance.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 170 m of active swallow colonies should be avoided; this distance incorporates the SWH around the colony plus a 120 m setback of adjacent land. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on the margins cliff SWH may damage or destroy the habitat. Large-scale vegetation clearing on adjacent lands may reduce the ecological function of the nesting habitat by reducing prey availability. The best mitigation option is to avoid developing in these locations.

When complete avoidance is not possible, set the nearest solar panels as far back from the edge of the bank or cliff as possible. Schedule construction activities to occur when the birds are not using the habitat, and keep heavy machinery away from bank margins. Avoid making any alteration to bank or cliff faces, and retain as much natural vegetation around the periphery of the project as possible. Natural erosion processes in shoreline embankments should be encouraged; the installation of rip-rap, armour-stone and other hard materials to the bank surface need to be minimized where possible. Riparian and aquatic vegetation along watercourses need to be maintained to provide habitat and food for forage insect species.

Where the development is upstream of significant bank nesting habitat, appropriate stormwater management practices should be implemented so that there are no significant changes in the hydrology of the stream.

ROAD DEVELOPMENT

Potential Development Effects

Road cuts often provide nesting habitats for Northern Rough-winged Swallows. There is an increasing tendency to shave back slopes on road cuts, thereby making them less suitable or unsuitable for colonies.

Mitigation Options

Development will not be permitted within 50 m of the most peripheral nests in a significant swallow colony unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Colonies of Northern Rough-winged Swallows inhabiting road cuts will probably not be identified as significant wildlife habitat. Nonetheless, municipalities should be educated as to the benefit of steep road cuts for these species, and encouraged to not reduce the slopes to the point where they become unsuitable for nesting. Potential nesting habitat along roads should only be provided or maintained where traffic is low and vehicle speeds are relatively slow. Otherwise, members of the colony may be subject to mortality from vehicle strikes.

INDEX #5: COLONIALLY-NESTING BIRD BREEDING HABITAT (TREE/SHRUB)

Ecoregions:	All of Ontario
Species Group:	Colonially-Nesting Birds (Tree/Shrub): Great Blue Heron, Great Egret, Green Heron, Black-crowned Night-Heron
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Breeding Habitat The Chimney Swift (THREATHENED) is protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that affect this species.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

The four species in this index are known to nest in dead trees in large marshes and lakes, flooded timber and shrubs adjacent to wetlands, and in flooded thickets over and adjacent to water. The Green Heron may also nest in non-forested wetland and forested non-wetland habitats, so it has also been included in Index #35 which deals with marsh bird breeding habitat.

See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Herons rarely tolerate human activity near their colonies (Bowman and Siderius 1984). The response of breeding herons to disruption is unpredictable; even apparently minor disturbances can lead to serious results. Birds nesting in large colonies and those accustomed to a certain amount of disturbance are less likely to desert the colony, although some nests may be deserted and nesting may be delayed (Bowman and Siderius 1984). Impacts that affect breeding success will reduce the ecological function of the nesting habitat.

Residential and commercial developments tend to increase human activity in the affected areas, which could have negative consequences for nearby heronries. The effects of human disturbance vary in response to a number of factors, including stage of the nesting cycle, degree of habituation to disturbance, size of the colony, species of heron present, and the nature of the disturbance. Important factors to consider are the timing of the disturbance in relation to critical periods of the nesting season, and the degree to which the birds are able to adjust to human activities in or near nesting areas (Bowman and Siderius 1984).

In many cases, the forested habitat for the species in this index is wetland. Draining, dredging, excavating, or filling portions of wetlands to establish development will have negative impacts on the function of the wetland as a nesting area for colonially nesting birds. This may result in direct habitat loss for these species. Additionally, the smaller wetland basin that will remain is likely to be subject to higher water levels due to reduced storage. Higher water levels are likely to kill any trees or shrubs that are currently in shallow water or at the water's edge and these may be used as nesting habitat for some of these species. Some colonies have been deserted after the destruction or alteration of their habitat during the non-nesting season (Bjorklund 1975).

Water levels may decline if development inhibits groundwater recharge, or if surface water is diverted away from the wetland. The water table may be lowered, and this could promote drying of the forest cover and conversion to upland habitat, which is seldom used other than by the Green Heron (although there are some Great Blue Heron rookeries in upland forest, albeit in relatively close proximity to water bodies). Drying may also promote windthrow in swamps, resulting in the loss of the larger trees that are preferred for nesting. Where colonies are situated in flooded timber, greatly reduced water levels make the nests vulnerable to predators such as raccoons, and heronries are often abandoned if water levels decline significantly.

Development on adjacent lands may have major effects on colonially nesting birds owing to disturbance effects. Tree-nesting species appear to be sensitive to pedestrians and often fly from the nest when people are a considerable distance away. Young of tree-nesting species may be lost if they panic and jump from the nest due to an intruder. Development often results in increased human and pet activity in the wetlands.

Mitigation Options

A minimum 300 m area of habitat beyond the most peripheral nests in a colony, or the extent of the forest ELC ecosite containing the colony, or any island less than 15.0 ha in size with a colony on it constitutes the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

If development is planned to occur in woodlands supporting heronries, it will probably not be possible to mitigate effects on the function of the remaining woodland as breeding habitat for colonial herons. Development should always be planned to ensure that forest area is not reduced. A reduction in forest size may result in the woodland being incapable of supporting species sensitive to human disturbance.

Development within a wooded wetland will greatly affect hydrology and therefore tree species composition. A water balance study should be conducted for any development within or adjacent to a lowland forest supporting a heron colony to ensure there will be no negative effects on the habitat.

Adjacent land development can be relatively benign provided care is taken to ensure that water or water-table levels do not change. Hydrological or hydro-geological studies may be required to predict changes in water levels and the duration, magnitude, and frequency of water-level fluctuations. If the site receives groundwater inputs, it needs to be demonstrated that development will not alter the amount of groundwater reaching the woodland.

For the species in this index, major development or even individual houses near the nesting area may not be compatible with retaining habitat. Development needs to be designed so that it does not encourage increased human usage of the woodland. It may be necessary to leave or create a visual barrier. Herons are sensitive to human presence during the breeding season.

Information is available on setback distances for some colonially nesting species. Within these setbacks, there should be no human activity. Generally, there should be no human incursion within 300 m of nesting herons. More detailed information is provided below.

OMNRF prepared management guidelines for the protection of heronries in Ontario (Bowman and Siderius 1984). This report summarized information available at that time on herons and the impacts of disturbance on colonially nesting herons. The authors suggested that buffer zones be established around each active heronry during the breeding season, which extends from March 15 to August 1 in southern Ontario (north to 44°N) and from April 1 to August 15 farther north (Bowman and Siderius 1984). The guidelines recommended two buffer zones around heronries: a heavy development buffer zone of 1,000 m and a minimum buffer zone of 300 m. In the heavy development buffer zone, it was recommended that construction activities be prohibited during the breeding season. In the minimum buffer zone, it was recommended that no removal or disturbance of vegetation occur at any time of the year, and that human access during the breeding season be restricted to research personnel. The authors also recommended an aquatic buffer zone of 300 m for heronries on the shorelines of islands, lakes and rivers. The 1984 guidelines were based on information in Buckley and Buckley (1978), the draft Alberta "Colonial Waterbird Management Plan", and personal communication from colonial waterbird experts.

Vos et al. (1985) found that Great Blue Herons were more easily disturbed early in the season and that birds remained away from the nest until the disturber left. Later in the nesting season, herons were more tolerant of disturbance and either returned to the nest more quickly or did not react. They recommended a buffer against human activities of 250 m for heronries on land and 150 m for those on islands, but also felt that the distance required to avoid disturbance might vary. Castrale (1994) recommended that development activity should not occur within 400 m of a Great Blue Heron colony during the breeding season, and that there should be a buffer area of 250 m around the heronry to protect it from human disturbance. Butler (1992) suggested that road building and logging within 500 m of a colony might result in disturbance.

For Great Egrets, buffers of 100 m around colonies have been recommended to protect the birds from disturbance by humans (Morrison and Shanley 1978; Chapman and Howard 1984; McCrimmon et al. 2001). In Ontario, all Great Egret breeding occurrences are in mixed wader rookeries, so the most conservative buffer, that for the Great Blue Heron) is to be used.

The Least Bittern does not appear to be overly sensitive to human disturbance. Bent (1926) noted that it nested within several cities and remained even when portions of the wetlands that it inhabited were being actively filled. It should be noted, however, that this is an old observation and the impacts of cities are now more intensive than 80 years ago; traffic noise, artificial lighting, stormwater runoff, and human recreation activities have become much more intense.

There appears to be very little information on the reactions of Green Herons to disturbance. Davis and Kushland (1994) suggested that increased recreational use of river channels leads to decreased use by Green Herons and reduced foraging. Given that the Green Heron typically nests solitarily in Ontario and that nest site fidelity may not be very strong, setbacks for this species may not be practical.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

The only types of major recreational development that are likely to affect this guild of colonial birds are golf courses and marinas.

Herons rarely tolerate human activity near their colonies (Bowman and Siderius 1984). The response of breeding herons to disruption is unpredictable; even apparently minor disturbances can lead to serious results. Birds nesting in large colonies and those accustomed to a certain amount of disturbance are less likely to desert the colony, although some nests may be deserted and nesting may be delayed (Bowman and Siderius 1984). Impacts that affect breeding success will reduce the ecological function of the nesting habitat.

Major recreational developments such as golf courses and marinas tend to increase human activity in the summer when herons are nesting; this could have negative consequences for nearby heronries. The effects of human disturbance vary in response to a number of factors, including stage of the nesting cycle, degree of habituation to disturbance, size of the colony, species of heron present, and the nature of the disturbance. Important factors to consider are the timing of the disturbance in relation to critical periods of the nesting season, and the degree to which the birds are able to adjust to human activities in or near nesting areas (Bowman and Siderius 1984).

In many cases, the forested habitat for the species in this index is wetland. Draining, dredging, excavating, or filling portions of wetlands to establish development will have negative impacts on the function of the wetland as a nesting area for colonially nesting birds. This may result in direct habitat loss for these species. Additionally, the smaller wetland basin that will remain is likely to be subject to higher water levels due to reduced storage. Higher water levels are likely to kill any trees or shrubs that are currently in shallow water or at the water's edge and these may be used as nesting habitat for some of these species. Some colonies have been deserted after the destruction or alteration of their habitat during the non-nesting season (Bjorklund 1975).

Water levels may decline if development inhibits groundwater recharge, or if surface water is diverted away from the wetland. The water table may be lowered, and this could promote drying of the forest cover and conversion to upland habitat, which is seldom used other than by the Green Heron (although there are some Great Blue Heron rookeries in upland forest, albeit in relatively close proximity to water bodies). Drying may also promote windthrow in swamps, resulting in the loss of the larger trees that are preferred for nesting. Where colonies are situated in flooded timber, greatly reduced water levels make the nests vulnerable to predators such as raccoons, and heronries are often abandoned if water levels decline significantly.

Development on adjacent lands may have major effects on colonially nesting birds owing to disturbance effects. Tree-nesting species appear to be sensitive to pedestrians and often fly from the nest when people are a considerable distance away. Young of tree-nesting species may be lost if they panic and jump from the nest due to an intruder.

Mitigation Options

A minimum 300 m area of habitat beyond the most peripheral nests in a colony, or the extent of the forest ELC ecosite containing the colony, or any island less than 15.0 ha in size with a colony on it constitutes the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

If development is planned to occur in woodlands supporting heronries, it will probably not be possible to mitigate effects on the function of the remaining woodland as breeding habitat for colonial herons. Golf courses should be planned to ensure that forest area is not reduced; fairways should be located outside any forest ecosite that supports a colony. A reduction in forest size may result in the woodland being incapable of supporting species sensitive to human disturbance.

A water balance study should be conducted for any development within or adjacent to a lowland forest that supports a breeding colony to ensure there will be no negative effects on the habitat.

Adjacent land development can be relatively benign provided care is taken to ensure that water or water-table levels do not change. Hydrological or hydro-geological studies may be required to predict changes in water levels and the duration, magnitude, and frequency of water-level fluctuations. If the site receives groundwater inputs, it needs to be demonstrated that development will not alter the amount of groundwater reaching the woodland.

For the species in this index, development near the nesting area may not be compatible with retaining habitat. Development should be designed so that it does not encourage increased human usage of the woodland. It may be necessary to leave or create a visual barrier. Herons are sensitive to human presence during the breeding season. Golf carts should never pass through woodlands supporting breeding colonies, and the active playing area of the golf course needs to be set back an appropriate distance from the colony.

Information is available on setback distances for some colonially nesting species. Within these setbacks, there should be no human activity. Generally, there should be no human incursion within 100 m of nesting herons. More detailed information is provided below.

OMNRF prepared management guidelines for the protection of heronries in Ontario (Bowman and Siderius 1984). This report summarized information available at that time on herons and the impacts of disturbance on colonially nesting herons. The authors suggested that buffer zones be established around each active heronry during the breeding season, which extends from March 1 to August 1 in southern Ontario (north to 44°N) and from April 1 to August 15 farther north (Bowman and Siderius 1984). The guidelines recommended two buffer zones around heronries: a heavy development buffer zone of 1,000 m and a minimum buffer zone of 300 m. In the heavy development buffer zone, it was recommended that construction activities be prohibited during the breeding season. In the minimum buffer zone, it was recommended that no removal or disturbance of vegetation occur at any time of the year, and that human access during the breeding season be restricted to research personnel. The authors also recommended an aquatic buffer zone of 300 m for heronries on the shorelines of islands, lakes and rivers. The 1984 guidelines were based on information in Buckley and Buckley (1978), the draft Alberta "Colonial Waterbird Management Plan", and personal communication from colonial waterbird experts.

Vos et al. (1985) found that Great Blue Herons were more easily disturbed early in the season and that birds remained away from the nest until the disturber left. Later in the nesting season, herons were more tolerant of disturbance and either returned to the nest more quickly or did not react. They recommended a buffer against human activities of 250 m for heronries on land and 150 m for those in water, but also felt that the distance required to avoid disturbance might vary. Castrale (1994) recommended that development activity should not occur within 400 m of a Great Blue Heron colony during the breeding season, and that there should be a buffer area of 250 m around the heronry to protect it from human disturbance. Butler (1992) suggested that road building and logging within 500 m of a colony might result in disturbance.

For Great Egrets, buffers of 100 m around colonies have been recommended to protect the birds from disturbance by humans (Morrison and Shanley 1978; Chapman and Howard 1984; McCrimmon et al. 2001). In Ontario, all Great Egret breeding occurrences are in mixed wader rookeries, so the most conservative buffer, that for the Great Blue Heron) need to be used.

The Least Bittern does not appear to be overly sensitive to human disturbance. Bent (1926) noted that it nested within several cities and remained even when portions of the wetlands that it inhabited were being actively filled. It should be noted, however, that this is an old observation and the impacts of cities are now more intensive than 80 years ago. Traffic noise, artificial lighting, stormwater runoff, and human recreation activities are much more intense now.

There appears to be very limited information on the reactions of Green Herons to disturbance. Davis and Kushland (1994) suggested that increased recreational use of river channels leads to decreased use by Green Herons and reduced foraging. Given that the Green Heron typically nests solitarily in Ontario and that nest site fidelity may not be that strong, setbacks for this species may not be practical.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

It is unlikely that any aggregate or mine development will have direct effects on the colonial birds in this index. There is, however, some potential for indirect effects primarily related to changes in hydrology.

If dewatering outflow is directed toward wetlands supporting colonial waterbirds, water levels may increase or there may be larger fluctuations in water levels. This has the potential to kill trees or shrubs that are supporting nests and may change the characteristics of the habitat from a thicket or treed swamp to a more open-water habitat that will not be suitable nesting habitat.

It is possible that extraction could lower the local water table and have adverse impacts on the habitat that is supporting the colony.

Background noise and blasting from pits and quarries also has the potential to disturb nesting birds. The response of breeding herons to disruption is unpredictable; even apparently minor disturbances can lead to serious results (Bowman and Siderius 1984). Birds nesting in large colonies and those accustomed to a certain amount of disturbance are less likely to desert the colony, although some nests may be deserted and nesting may be delayed (Bowman and Siderius 1984). Impacts that affect breeding success will reduce the ecological function of the nesting habitat.

Dust from pit and quarry operations have the potential to deposit extensive particulate matter which may negatively impact forest canopies and thus habitat for nesting herons.

Mitigation Options

A minimum 300 m area of habitat beyond the most peripheral nests in a colony, or the extent of the forest ELC ecosite containing the colony, or any island less than 15.0 ha in size with a colony on it constitutes the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

De-watering outflow should be directed away from any wetland that support a heronry. If outflow must enter the wetland, appropriate stormwater management facilities need to be designed, constructed, and maintained so that there are no significant changes in water quantities delivered to the wetland. The existing hydro-period should also be mimicked.

If there is potential that aggregate extraction will result in a change in groundwater levels or flows, a hydro-geological study will be required. If potential impacts are identified that will affect the habitat supporting the colony, mitigation will be required to minimize effects. This could include limiting the depth of extraction, installing impermeable barriers around the extraction areas, or pumping suitable volumes of water until the pit or quarry is rehabilitated. These latter mitigation techniques have been recommended for several quarry applications, but their efficacy is as yet unknown.

To avoid disturbance of nesting herons, pits and quarries that are situated within the SWH should consider curtailing operations during the breeding season.

Appropriate dust suppression techniques should be implemented to minimize deposition of particulate matter beyond operational boundaries.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Wind energy projects have the potential to adversely affect birds through direct fatalities, disturbance, and habitat loss (Kingsley and Whittam 2005; Environment Canada 2007a). With a few important exceptions (e.g., raptors in California), avian fatalities at wind power facilities tend to be low relative to other anthropogenic mortality factors (Kingsley and Whittam 2005). Collisions occur mainly at sites where there are unusual concentrations of birds (e.g., migration corridors) and wind turbines, or where the behaviour of birds puts them at risk (e.g., aerial courtship displaying) (Arcus Renewable Energy Consulting Ltd. 2007).

Greater adverse effects from wind power facility development result from disturbance and habitat loss (Kingsley and Whittam 2005).

The effect of disturbance from wind turbines on nesting herons and other colonial waterbirds may be a legitimate concern (Kingsley and Whittam 2005). For example, heronries are often situated in areas isolated from human disturbance (Bowman and Siderius 1984). Herons that have experienced little past disturbance are unlikely to tolerate human activity near their colonies. Some colonies have been deserted after the destruction or alteration of their habitat during the non-nesting season (Bjorklund 1975). Birds nesting in large colonies and those accustomed to a certain amount of disturbance are less likely to desert the colony, although some nests may be deserted and nesting may be delayed (Bowman and Siderius 1984). Impacts that affect breeding success will reduce the ecological function of the nesting habitat.

Nesting waterbirds in this guild may also be disturbed if moving turbine blades are visible from the colony. Great Blue Herons are also sensitive to noise near the colony, especially early in the nesting season; when loud noises occur nearby, herons may leave nests unguarded and vulnerable to avian predators such as crows (Butler and Baudin 2000).

In many cases, the forested habitat for the species in this index is wetland. Draining, dredging, excavating, or filling portions of wetlands to establish development will have negative impacts on the function of the wetland as a nesting area for colonially nesting birds. Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Clearing may result in the loss of nest trees and/or shrubs, or have an indirect affect by reducing the buffer area between the nesting colony and human activity on adjacent developments.

In the United Kingdom, Arcus Renewable Energy Consulting Ltd. (2007) conducted an environmental assessment of the proposed Bagot's Park Windfarm near East Staffordshire. The authors concluded that the development would have "moderate" negative effects on a colony of Grey Herons (the Eurasian counterpart to North America's Great Blue Heron) 700 m distant from the planned location of the nearest turbine. The concern was that herons flying past turbines enroute to feeding areas were at risk of mortality through collision with rotating blades.

Mitigation Options: Wind Power Facilities

A minimum 300 m area of habitat beyond the most peripheral nests in a colony, or the extent of the forest ELC ecosite containing the colony, or any island less than 15.0 ha in size with a colony on it constitutes the SWH. The siting of wind turbines within a 120 m set-back from the SWH should be avoided. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in tree/shrub nesting SWH will result in the physical destruction of the affected habitat. Human activities related to construction and regular maintenance of turbines will likely disturb birds using the colony, thereby reducing the habitat's ecological function. The best mitigation option is to avoid developing in the habitat.

For development on adjacent lands, timing construction to occur outside of the breeding season may satisfactorily mitigate some disturbance impacts. Activities that have a high disturbance factor over the short-term (e.g., construction noise and activity, forest clearing and site preparation, blasting, dredging) should be scheduled to occur outside the breeding season. For example, Great Blue Herons breed from March 15 to August 1 in southern Ontario and from April 1 to August 15 in northern Ontario (Bowman and Siderius 1984). However, note that some colonies have been deserted after the destruction or alteration of their habitat during the non-nesting season (Bjorklund 1975).

Longer-term disturbances such as the noise and movement of turbine blades may be harder to mitigate. Options include locating turbines where they are not visible to nesting birds in the colony, leaving a visual barrier of tall trees between the colony and the turbines, and/or using turbines that are shorter than the nest trees in the colony.

Direct mortality through collision with turbine blades can be most effectively mitigated by good site selection. Avoid locating turbines where they intercept birds moving between the breeding colony and feeding areas. For the proposed Bagot's Park Windfarm, recommended mitigation measures to protect nesting Grey Herons included shutting turbines down during periods of high activity when herons were moving from the heronry to their feeding grounds (Arcus Renewable Energy Consulting Ltd. 2007). Even with this mitigation measure in place, the potential effect of collision mortality on Grey Herons over the long term (i.e., the lifetime of the wind power facility) was considered to be significant. The Bagot's Park Windfarm has not yet been developed.

When important factors remain unclear and an indication exists for an important negative impact, the precautionary principle must be applied (Everaert and Kuijken 2007).

Potential Development Effects: Solar Power Facilities

Herons rarely tolerate human activity near their colonies (Bowman and Siderius 1984). The response of breeding herons to disruption is unpredictable; even apparently minor disturbances can lead to serious results. Birds nesting in large colonies and those accustomed to a certain amount of disturbance are less likely to desert the colony, although some nests may be deserted and nesting may be delayed (Bowman and Siderius 1984). Impacts that affect breeding success will reduce the ecological function of the nesting habitat.

Increase human activity associated with construction and maintenance activities could have negative consequences for nearby heronries. The effects of human disturbance vary in response to a number of factors, including stage of the nesting cycle, degree of habituation to disturbance, size of the colony, species of heron present, and the nature of the disturbance. Important factors to consider are the timing of the disturbance in relation to critical periods of the nesting season, and the degree to which the birds are able to adjust to human activities in or near nesting areas (Bowman and Siderius 1984).

In many cases, the forested habitat for the species in this index is wetland. Draining, dredging, excavating, or filling portions of wetlands to establish development will have negative impacts on the function of the wetland as a nesting area for colonially nesting birds. This may result in direct habitat loss for these species. Additionally, the smaller wetland basin that will remain is likely to be subject to higher water levels due to reduced storage. Higher water levels are likely to kill any trees or shrubs that are currently in shallow water or at the water's edge and these may be used as nesting habitat for some of these species. Some colonies have been deserted after the destruction or alteration of their habitat during the non-nesting season (Bjorklund 1975).

Development on adjacent lands may have major effects on colonially nesting birds owing to disturbance effects. Tree-nesting species appear to be sensitive to pedestrians and often fly from the nest when people are a considerable distance away. Young of tree-nesting species may be lost if they panic and jump from the nest due to an intruder.

Mitigation Options: Solar Power Facilities

A minimum 300 m area of habitat beyond the most peripheral nests in a colony, or the extent of the forest ELC ecosite containing the colony, or any island less than 15.0 ha in size with a colony on it constitutes the SWH. The siting of solar panel arrays within a 120 m set-back from the SWH should be avoided. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in tree/shrub nesting SWH will result in the physical destruction of that portion of the habitat that is under the development footprint. A reduction in forest size may result in the woodland being incapable of supporting species sensitive to human disturbance. Human activities related to construction and regular maintenance of solar panel arrays will likely disturb birds using the colony, thereby reducing the ecological function of retained habitat. The best mitigation option is to avoid developing in the habitat.

For development on adjacent lands, timing construction to occur outside of the breeding season may satisfactorily mitigate some disturbance impacts. Activities that have a high disturbance factor over the short-term (e.g., construction noise and activity, forest clearing and site preparation, blasting, dredging) should be scheduled to occur outside the breeding season. For example, Great Blue Herons breed from March 15 to August 1 in southern Ontario and from April 1 to August 15 in northern Ontario (Bowman and Siderius 1984). However, note that some colonies have been deserted after the destruction or alteration of their habitat during the non-nesting season (Bjorklund 1975).

Longer-term disturbances, such as human activity associated with regular maintenance at the project site, may be harder to mitigate. Options include locating the project where it is not visible to nesting birds in the colony, leaving a visual barrier of tall trees between the colony and the project, and/or scheduling regular maintenance to occur when birds are not using the colony.

Development within a wooded wetland will greatly affect hydrology and therefore tree species composition. A water balance study should be conducted for any development within or adjacent to a lowland forest supporting a heron colony to ensure there will be no negative effects on the habitat.

When important factors remain unclear and an indication exists for an important negative impact, the precautionary principle must be applied (Everaert and Kuijken 2007).

ROAD DEVELOPMENT

Potential Development Effects

Roads are most likely to affect nesting colonies indirectly through changes in hydrology and disturbance.

Roads have the potential to act as a dam, thereby increasing water levels on one side of the road and decreasing them on the other. Where this occurs in swamps, trees often die on the wetter side and are replaced by cattail marsh, which is not suitable breeding habitat for some of the species in this guild. Trees on the drier side usually persist, but succession may change from red or silver maple to regeneration of trembling aspen and birch once the older trees die off. These latter tree species are generally unsuitable nest trees.

Herons rarely tolerate human activity near their colonies (Bowman and Siderius 1984). The response of breeding herons to disruption is unpredictable; even apparently minor disturbances can lead to serious results. Birds nesting in large colonies and those accustomed to a certain amount of disturbance are less likely to desert the colony, although some nests may be deserted and nesting may be delayed (Bowman and Siderius 1984). Impacts that affect breeding success will reduce the ecological function of the nesting habitat.

Road development tend to increase human activity in the affected areas, which could have negative consequences for nearby heronries. The effects of human disturbance vary in response to a number of factors, including stage of the nesting cycle, degree of habituation to disturbance, size of the colony, species of heron present, and the nature of the disturbance. Important factors to consider are the timing of the disturbance in relation to critical periods of the nesting season, and the degree to which the birds are able to adjust to human activities in or near nesting areas (Bowman and Siderius 1984).

Mitigation Options

A minimum 300 m area of habitat beyond the most peripheral nests in a colony, or the extent of the forest ELC ecosite containing the colony, or any island less than 15.0 ha in size with a colony on it constitutes the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

To minimize disturbance, roads need to be 250-400 m away from an active colony. OMNR (2008a) recommended that roads be 200-300 m from a Great Blue Heron colony, but these were logging roads and other roads may have greater impacts due to higher traffic volumes and noise. If the road must be closer than this, thought needs to be given to avoiding construction during the early part of the breeding season (from early April until the end of June). This is when herons are most likely to desert nests; the birds become more tolerant of disturbance later in the season.

Where possible, roads should always be routed such that they do not cut through wetlands that support colonies. If the wetland that supports the colony cannot be avoided, the road needs to be placed as close to the edge as possible to minimize the effects of habitat fragmentation. Additionally, sufficient culverts should be installed under the road to ensure that lateral drainage is not impeded. Where possible, roadside ditches should never be designed so that they remove water from the wetland and cause localized drying.

If road development is planned in woodlands supporting heronries, it will probably not be possible to mitigate effects on the function of the remaining woodland as breeding habitat for colonial herons. Development should always be planned to ensure that forest area is not reduced. A reduction in forest size may result in the woodland being incapable of supporting species sensitive to human disturbance.

Information is available on setback distances for some colonially nesting species. Within these setbacks, there should be no human activity. Generally, there should be no human incursion within 300 m of nesting herons. More detailed information is provided below.

OMNRF prepared management guidelines for the protection of heronries in Ontario (Bowman and Siderius 1984). This report summarized information available at that time on herons and the impacts of disturbance on colonially nesting herons. The authors suggested that buffer zones be established around each active heronry during the breeding season, which extends from March 15 to August 1 in southern Ontario (north to 44°N) and from April 1 to August 15 farther north (Bowman and Siderius 1984). The guidelines recommended two buffer zones around heronries: a heavy development buffer zone of 1,000 m and a minimum buffer zone of 300 m. In the heavy development buffer zone, it was recommended that construction activities be prohibited during the breeding season. In the minimum buffer zone, it was recommended that no removal or disturbance of vegetation occur at any time of the year, and that human access during the breeding season be restricted to research personnel. The authors also recommended an aquatic buffer zone of 300 m for heronries on the shorelines of islands, lakes and rivers. The 1984 guidelines were based on information in Buckley and Buckley (1978), the draft Alberta "Colonial Waterbird Management Plan", and personal communication from colonial waterbird experts.

Vos et al. (1985) found that Great Blue Herons were more easily disturbed early in the season and that birds remained away from the nest until the disturber left. Later in the nesting season, herons were more tolerant of disturbance and either returned to the nest more quickly or did not react. They recommended a buffer against human activities of 250 m for heronries on land and 150 m for those on islands, but also felt that the distance required to avoid disturbance might vary. Castrale (1994) recommended that development activity should not occur within 400 m of a Great Blue Heron colony during the breeding season, and that there should be a buffer area of 250 m around the heronry to protect it from human disturbance. Butler (1992) suggested that road building and logging within 500 m of a colony might result in disturbance.

For Great Egrets, buffers of 100 m around colonies have been recommended to protect the birds from disturbance by humans (Morrison and Shanley 1978; Chapman and Howard 1984; McCrimmon et al. 2001). In Ontario, all Great Egret breeding occurrences are in mixed wader rookeries, so the most conservative buffer, that for the Great Blue Heron) is to be used.

The Least Bittern does not appear to be overly sensitive to human disturbance. Bent (1926) noted that it nested within several cities and remained even when portions of the wetlands that it inhabited were being actively filled. It should be noted, however, that this is an old observation and the impacts of cities are now more intensive than 80 years ago; traffic noise, artificial lighting, stormwater runoff, and human recreation activities have become much more intense.

There appears to be very little information on the reactions of Green Herons to disturbance. Davis and Kushland (1994) suggested that increased recreational use of river channels leads to decreased use by Green Herons and reduced foraging. Given that the Green Heron typically nests solitarily in Ontario and that nest site fidelity may not be very strong, setbacks for this species may not be practical.

INDEX #6: COLONIALLY-NESTING BIRD BREEDING HABITAT (GROUND)

Ecoregions:	All of Ontario
Species Group:	Colonially-Nesting Birds (Ground Nesting): Ring-billed Gull, Herring Gull, Great Black-backed Gull, Common Tern, Caspian Tern, Little Gull, Wilson's Phalarope, Brewer's Blackbird
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Nesting Areas
Habitat Features:	Any (rocky) island or peninsula (natural or artificial) within a lake or large river (2-lined on a 1:50,000 NTS map)

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Shorelines, and more often offshore islands, are preferred habitat for a number of different bird species which nest in colonies ranging in size from a few individuals to groups of hundreds or even thousands. These birds will tolerate close nesting by the same species due in part to the relative scarcity of suitable nesting habitat offering the safety and seclusion provided by water. Colonial nesting provides members a predator alert system. If there is invasion of predators, colony members will start a warning call or behaviour pattern that alerts all birds in the colony. Some species also swarm and "dive bomb" potential nest predators to drive them away. Nesting in colonies also reduces the probability of any one nest being destroyed by a predator. Older and more experienced birds usually nest in the centre of the colony while first-time nesters are usually forced to nest on the periphery of the colony. The water surrounding colonies serves as a barrier to many potential nest predators. Surrounding open water provides a productive food source for some colonially-nesting species.

The number of Ring-billed Gulls in urban and suburban areas has raised concerns about airline flight safety, human health, agricultural and horticultural damage, nesting on urban roofs and interfering with industrial operations, incompatibility with land use (parks), and encroachment on Common Tern nesting habitat (Ryder 1993). The status of the local population may be taken into account when planning authorities are deciding on the level of protection offered to the species (OMNR 2000). It is rare that eradication of nesting sites for the species will be warranted, but it may not be desirable to allow populations to increase in some areas. These birds are also protected under the Migratory Birds Convention Act and federal permits are required to interfere with their nests.

The structure and composition of open water shoreline ecosystems which function as colonial-nesting areas varies among bird species. See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Excavation and building on portions of shorelines will have negative impacts on the function of the shoreline as a nesting area for colonially-nesting birds. These species are intolerant of human disturbance while nesting even though nesting habitat may be in relatively close proximity to urban/developed areas (e.g., Leslie Street Spit in Toronto). Even developments affecting relatively small portions of undisturbed islands will cause birds to abandon the site as a nesting area.

Increased human activity during the nesting season (April through July) is not compatible with the functioning of shoreline areas as nesting habitat. Even infrequent disturbance of island sites may cause birds to abandon the site. Limited studies have been done on the distance that human activities affect breeding birds nesting in colonies. It is known, however, that birds react more negatively to walking humans than those in vehicles such as cars, motorboats, or canoes (Rodgers 1991). Slow-moving watercraft, such as canoes, cause greater disturbance than fast moving boats, although wake created from motorboats may flood nests that are near the shoreline. Additionally, construction noise during the breeding season has been known to disturb breeding colonial waterbirds, resulting in decreased use of the affected colony (Mueller and Glass 1988). The authors concluded that disturbance during the early spring, when birds were selecting nest sites and establishing territories, was responsible for the observed results.

Development on adjacent lands may have major effects on colonially-nesting birds owing to disturbance effects. Increased numbers of cottages and boats on lakes or rivers where there are nesting colonies may result in nesting disturbance, as may human visits to nesting areas along shorelines. The nests of all of these species are occasionally destroyed by humans who perceive them to be a threat to their own fishing success. Mainland colonies are also highly susceptible to mammalian predators. Numbers of raccoons, skunks, cats, and dogs typically increase in association with development. A single nocturnal visit by a predator can result in the abandonment of the colony overnight and high mortality of eggs and chicks. Entire colonies have been deserted as a result of a single mammalian predator.

Mitigation Options

A minimum 150 m area of habitat beyond the most peripheral nests in a colony, or the extent of the ELC ecosite containing the colony, or any island less than 3.0 ha in size with a colony on it constitutes the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on small islands being used by birds as nesting areas is incompatible with colonially-nesting birds. Nesting islands and shoreline-colonial nesting sites represent important habitat for large populations of birds, all of which are sensitive to human disturbance. These sites should always be avoided by development. Large-scale development adjacent to mainland nesting colonies will probably result in the loss of the colony unless humans and predators can be excluded. Impacts on a colony may affect regional populations of the species involved. It may be possible to create new nesting islands such as has been done successfully in Hamilton Harbour. The colonies of many of these species are situated on anthropogenic sites such as islands created from dredged material or fill (Quinn et al. 1996).

Seasonal controls of human access to areas being used as nesting habitat will be required. Successful mitigation generally involves avoiding the nesting area for development and ensuring that there will be no access by humans or predators from adjacent developments during the breeding season. A Florida study recommends a setback distance of 125 m for wading birds and 175 m for terns to protect breeding colonies from human disturbances (Rodgers 1991).

Schedule all construction activities to occur outside the breeding season.

Caspian Terns are highly sensitive to disturbance and may take flight when a predator or human approaches within 100 to 200 m (Cuthbert 1985, 1988; Blokpoel and Scharf 1991; Blokpoel and Tessier 1991; Cuthbert and Wires 1999). Entire colonies of Common Terns have been known to flush when humans were as far away as 150 m (Carney and Sydeman 1999; Nisbet 2002). No information on flushing distances was found for other species in this guild, although they appear to flush at closer distances than terns and are therefore somewhat less susceptible to disturbance.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses and marinas are the types of major recreational development that are likely to affect birds in this guild.

Excavation and building on portions of shorelines will have negative impacts on the function of the shoreline as a nesting area for colonially-nesting birds. These species are intolerant of human disturbance while nesting even though nesting habitat may be in relatively close proximity to urban/developed areas (e.g., Leslie Street Spit in Toronto). Even developments affecting relatively small portions of undisturbed islands will cause birds to abandon the site as a nesting area.

Increased human activity during the nesting season (April through July) is not compatible with the functioning of shoreline areas as nesting habitat. Even infrequent disturbance at island sites may cause birds to abandon the site. Limited studies have been done on the distance that human activities affect breeding birds nesting in colonies. It is known, however, that birds react more negatively to walking humans than those in vehicles such as cars, motorboats, or canoes (Rodgers 1991). Slow-moving watercraft, such as canoes, cause greater disturbance than faster boats, although wake action from motorboats may flood nests that are near the shoreline. Additionally, construction noise during the breeding season has been known to disturb breeding colonial waterbirds, resulting in decreased use of the affected colony (Mueller and Glass 1988). The authors concluded that disturbance during the early spring, when birds were selecting nest sites and establishing territories, was responsible for the observed results.

Development on adjacent lands may have major effects on colonially-nesting birds owing to disturbance effects. Increased numbers of boats on lakes or rivers where there are nesting colonies may result in nesting disturbance, as may human visits to nesting areas along shorelines. The nests of all of these species are occasionally destroyed by humans who perceive them to be a threat to their own fishing success. Mainland colonies are also highly susceptible to mammalian predators. Numbers of raccoons, skunks, cats, and dogs typically increase in association with development. A single nocturnal visit by a predator can result in the abandonment of the colony overnight and high mortality of eggs and chicks. Entire colonies have been deserted as a result of a single mammalian predator.

Mitigation Options

A minimum 150 m area of habitat beyond the most peripheral nests in a colony, or the extent of the ELC ecosite containing the colony, or any island less than 3.0 ha in size with a colony on it constitutes the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Nesting islands and shoreline-colonial nesting sites represent important habitat for large populations of birds, all of which are sensitive to human disturbance. These sites should always be avoided by development. Marina or golf course development adjacent to mainland nesting colonies will probably result in the loss of the colony unless humans and predators can be excluded. Impacts on a colony may affect regional populations of the species involved.

Seasonal controls of human access to areas being used as nesting habitat will be required. Successful mitigation generally involves avoiding the nesting area for development and ensuring that there will be no access by humans or predators from adjacent developments during the breeding season. A Florida study recommends a setback distance of 125 m for wading birds and 175 m for terns to protect breeding colonies from human disturbances (Rodgers 1991).

Schedule all construction activities to occur outside the breeding season.

Caspian Terns are highly sensitive to disturbance and may take flight when a predator or human approaches within 100 to 200 m (Cuthbert 1985, 1988; Blokpoel and Scharf 1991; Blokpoel and Tessier 1991; Cuthbert and Wires 1999). Entire colonies of Common Terns have been known to flush when humans were as far away as 150 m (Carney and Sydeman 1999; Nisbet 2002). No information on flushing distances was found for other species in this guild, although they appear to flush at closer distances than terns and are therefore somewhat less susceptible to disturbance.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

No potential impacts have been identified for this development category.

Mitigation Options

No potential impacts have been identified for this development category.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Wind energy projects have the potential to adversely affect birds through direct fatalities, disturbance, and habitat loss (Kingsley and Whittam 2005; Environment Canada 2007a). With a few important exceptions (e.g., raptors in California), avian fatalities at wind power facilities tend to be low relative to other anthropogenic mortality factors (Kingsley and Whittam 2005). Collisions occur mainly at sites where there are unusual concentrations of birds (e.g., migration corridors) and wind turbines, or where the behaviour of birds puts them at risk (e.g., aerial courtship displaying) (Arcus Renewable Energy Consulting Ltd. 2007).

Greater adverse effects from wind power facility development result from disturbance and habitat loss (Kingsley and Whittam 2005).

Shoreline and offshore areas are attractive locations for wind power facilities due to the frequency and velocity of winds. Nesting islands and shorelines represent important habitat for large populations of birds. Many ground-nesting colonial birds are readily disturbed by human activity near breeding colonies, and have been reported to abandon the breeding colony because of it (ESS Group, Inc. et al. 2004:9). The presence of operating wind turbines may cause a site to be abandoned (Exo et al. 2003; Kingsley and Whittam 2005).

Additionally, construction noise during the breeding season has been known to disturb breeding colonial waterbirds, resulting in decreased use of the affected colony (Mueller and Glass 1988). The authors concluded that disturbance during the early spring, when birds were selecting nest sites and establishing territories, was responsible for the observed results.

Large-scale development adjacent to nesting colonies has the potential to result in long-term habitat loss due to disturbance by turbines and activities associated with maintenance (Exo et al. 2005; Kingsley and Whittam 2005). Impacts on a colony may affect regional populations of the species involved.

Poorly sited turbines may act as a barrier between breeding colonies and feeding areas (Kingsley and Whittam 2005), putting foraging birds at risk of mortality by collision with rotating turbine blades and associated transmission wires. Collision mortality for ground-nesting colonial birds has been reported for gulls, terns, shorebirds, pelicans and blackbirds (Kingsley and Whittam 2005). For example, substantial mortality of Common Terns has occurred due to wind power facilities in Belgium (Everaert and Stienen 2007; Stienen et al. 2008). Foraging terns were most at risk (Stienen et al. 2008). Gulls are also vulnerable as they often fly at heights that fall within the rotational sphere of turbine blades (Airola 1987, in Kingsley and Whittam 2005). Shorebirds appear to be particularly vulnerable to collision with wires (Kinglsey and Whittam 2005). Negative impacts on birds using a breeding colony will, in turn, have a negative impact on the colony itself by reducing its ecological function as breeding habitat.

Mitigation Options: Wind Power Facilities

A minimum 150 m area of habitat beyond the most peripheral nests in a colony, or the extent of the ELC ecosite containing the colony, or any island less than 3.0 ha in size with a colony on it constitutes the SWH. The siting of wind turbines within 120 m of the SWH should be avoided. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development of wind power facilities near any important breeding colony of terns or gulls should be avoided (Environment Canada 2007a; Everaert and Stienen 2007). In the United Kingdom, the government conservation agency English Nature recommends that turbines should not be located within 1000 m of sensitive or important gull or tern colonies (Percival 2001, in Kingsley and Whittam 2005).

Timing construction to occur outside of the breeding season may satisfactorily mitigate some disturbance impacts. Activities that have a high disturbance factor over the short-term (e.g., construction noise and activity, land clearing and site preparation, blasting, dredging) should be scheduled to occur outside the breeding season. Longer-term disturbances such as the noise and movement of turbine blades may be harder to mitigate. Options include locating turbines where they are not visible to nesting birds in the colony, and/or leaving a visual barrier of tall trees between the colony and the turbines.

Disturbance impacts related to maintenance activities can be mitigated by scheduling regular maintenance to occur outside the breeding season.

To mitigate mortality losses through collisions with turbine blades and overhead wires, towers should be sited outside areas of high activity around nesting colonies, e.g., the flight path between the colony and its main foraging area (Everaert and Stienen 2007).

Potential Development Effects: Solar Power Facilities

Development on the margins of shoreline habitat will have negative impacts on the function of the shoreline as a nesting area for colonially-nesting birds. These species are intolerant of human disturbance while nesting even though nesting habitat may be in relatively close proximity to urban/developed areas (e.g., Leslie Street Spit in Toronto). Even developments affecting relatively small portions of undisturbed islands will cause birds to abandon the site as a nesting area.

Increased human activity during the nesting season (April through July) is not compatible with the functioning of shoreline areas as nesting habitat. Even infrequent disturbance of island sites may cause birds to abandon the site. Limited studies have been done on the distance that human activities affect breeding birds nesting in colonies. It is known, however, that birds react more negatively to walking humans than those in vehicles such as cars, motorboats, or canoes (Rodgers 1991). Slow-moving watercraft, such as canoes, cause greater disturbance than fast moving boats, although wake created from motorboats may flood nests that are near the shoreline. Additionally, construction noise during the breeding season has been known to disturb breeding colonial waterbirds, resulting in decreased use of the affected colony (Mueller and Glass 1988). The authors concluded that disturbance during the early spring, when birds were selecting nest sites and establishing territories, was responsible for the observed results.

Development on adjacent lands may have major effects on colonially-nesting birds owing to disturbance effects. Construction and maintenance activities associated with the project may result in nesting disturbance.

Mitigation Options: Solar Power Facilities

A minimum 150 m area of habitat beyond the most peripheral nests in a colony, or the extent of the ELC ecosite containing the colony, or any island less than 3.0 ha in size with a colony on it constitutes the SWH. The siting of solar panel arrays within 120 m of the SWH should be avoided. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on small islands being used by birds as nesting areas is incompatible with colonially-nesting birds. Successful mitigation generally involves avoiding the nesting area for development and ensuring that there will be no access by humans from adjacent developments during the breeding season. A Florida study recommends a setback distance of 125 m for wading birds and 175 m for terns to protect breeding colonies from human disturbances (Rodgers 1991).

Large-scale development adjacent to mainland nesting colonies will probably result in the loss of the colony unless humans can be excluded. Scheduling activities that have a high short-term disturbance factor (e.g., construction noise and activity, land clearing and site preparation, blasting, dredging) to occur outside the breeding season may mitigate some of the disturbance effects. Longer-term disturbances such as human activities relating to regular maintenance may be harder to mitigate. Options include locating solar panel arrays where they are not visible to nesting birds in the colony, leaving a visual barrier of natural vegetation between the colony and the project, and/or scheduling regular maintenance activities to occur when the birds are not using the colony.

It may also be possible to create new nesting islands; this mitigation option has been successful in Hamilton Harbour. The colonies of many of these species are situated on anthropogenic sites such as islands created from dredged material or fill (Quinn et al. 1996).

Caspian Terns are highly sensitive to disturbance and may take flight when a human approaches within 100 to 200 m (Cuthbert 1985, 1988; Blokpoel and Scharf 1991; Blokpoel and Tessier 1991; Cuthbert and Wires 1999). Entire colonies of Common Terns have been known to flush when humans were as far away as 150 m (Carney and Sydeman 1999; Nisbet 2002). No information on flushing distances was found for other species in this guild, although they appear to flush at closer distances than terns and are therefore somewhat less susceptible to disturbance.

ROAD DEVELOPMENT

Potential Development Effects

No potential impacts have been identified for this development category.

Mitigation Options

No potential impacts have been identified for this development category.

INDEX #7: WATERFOWL STOPOVER AND STAGING AREAS

Ecoregions:	All of Ontario
Species Group:	5E, 6E and 7E: Canada Goose, Crackling Goose, Snow Goose, American Black Duck, Northern Pintail, Northern Shoveler, American Wigeon, Gadwell, Green-winged Teal, Blue-winged Teal, Hooded Merganser, Common Metrganser, Lesser Scaup, Greater Scaup, Long-tailed Duck, Surf Scoter, White-winged Scoter, Black Scoter, Ring-necked Duck, Common Goldeneye, Bufflehead, Redhead, Ruddy Duck, Red-breasted Merganser, Brant, Canvasback, Wood Duck, Mallard, 7E: also Tundra Swan
Significant Wildlife Habitat Category:	Seasonal Concentration Areas
Functional Habitat:	Stopover and Staging Areas
Habitat Features:	Fields with evidence of annual spring flooding from meltwater or runoff; aquatic habitats including large marshy wetlands

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Waterfowl often stop in traditional areas during spring and autumn migration to rest, feed and/or wait out bad flying weather. Large numbers of migrating waterfowl may concentrate in traditionally used areas. The length of time that individual birds stay in staging areas varies. Large numbers may leave together if ideal weather conditions arise. Some species of waterfowl using staging areas may forage in nearby agricultural crops. Sometimes the most important staging areas are the only large marshes with open water in the surrounding area. Therefore, all of the birds tend to gravitate to that site.

Waterfowl staging habitat requirements are somewhat different in spring and autumn, as described for some species in appendix K of OMNR 2000. This may relate to where the birds nest and how close they are to the nesting or wintering areas. Many birds arrive on the lower Great Lakes unpaired in the spring, while others pair during winter. Pairing for the first group of species may occur on the Great Lakes and major southern rivers, and is completed by the time the nesting areas are reached. Some of the more arctic species may stage in large numbers in the south waiting for the breeding grounds to thaw. In autumn, migration is often more leisurely, with birds often remaining until freeze-up.

Staging areas are an important component of migration traditions. The network of staging areas which occurs in major North American waterfowl flyways ensures safe conveyance of birds between winter and summer range. Large coastal or lakeshore wetlands may also serve as navigation aids to migrating waterfowl. Staging areas are often situated at a point in the migration where the birds need to replenish energy reserves and rest before continuing. For example, fields with waste grain and seasonal flooding in the Long Point, Rondeau, Lake St. Clair, Grand Bend and Point Pelee areas may be important to Tundra Swans (OMNR 2000). For some other waterfowl species, agricultural fields with waste grains are commonly used by waterfowl, these are not considered SWH unless they have spring sheet water available.

Waterfowl use a variety of wetlands as staging areas. Larger wetlands seem to be preferred and those associated with shorelines attract the largest concentrations. Marshes which provide a good interspersion of open water and submergent and emergent plant cover are high quality sites because they provide an optimum mix of food and cover. Some of the autumn staging areas are also used as night-time roosts. Several hundred waterfowl may use a larger pond or wetland as an over-night roost, dispersing to smaller water bodies during the day to feed. Night-time roosts are often thick willow thicket swamps or wetlands with a mix of marsh and swamp. These sites are important in providing cover and protection from predators, but they may be deficient in food supplies. Diving ducks and sea ducks may stage in more open-water habitat as opposed to wetlands.

See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Draining, dredging, excavating, or filling portions of wetlands to establish development will have negative impacts on the function of the wetland as a waterfowl staging area. This may result in direct habitat loss for these species. Additionally, the smaller wetland basin that will remain is likely to be subject to higher water levels due to reduced storage. The deeper water is likely to reduce the extent of aquatic submergent and emergent vegetation, which is critical to many of these species. Deeper water may also kill shrubs and trees living on hummocks in the water or along the shoreline. Some of the waterfowl species in this guild require large wetlands so that they are safe from predators and disturbance. If the wetland area is decreased, habitat may no longer be suitable for area-sensitive species.

Changes to water levels may result from adjacent development. Because many migrating waterfowl species have specific vegetation density or species requirements, they will abandon sites when vegetation cover becomes too sparse or dense, or if dominant species change. Changes in the ratio of emergent cover to open water may also affect habitat quality for many species. If significant areas of marshland vegetation are affected, then the marsh may cease to function as waterfowl staging habitat.

Water levels may decline if development inhibits groundwater recharge, or if surface water is diverted away from the wetland. Declining water levels are likely to increase the amount of vegetation in the wetland and change the vegetation composition. Lower water levels may make the habitat unsuitable for species that require deeper water and more submergents than emergents. This can be a serious problem on many inland ponds and marshes. Too little water is probably more detrimental to waterfowl staging than too much water.

Water levels may increase if a significant portion of the wetland's watershed is hardened resulting in a higher percentage of precipitation being directed to the wetland. Diversion of water by development may also increase the watershed area. Higher water levels will result in less aquatic vegetation and more open water. This may make the habitat unsuitable for certain species, particularly those that prefer extensive stands of emergents or prefer shallow water. Deeper water may enhance conditions for species that prefer submergents, at the expense of those that require emergents.

Development may also change the frequency, duration, and magnitude of water-level fluctuations through creation of impervious areas. Unnatural water-level fluctuations may affect distribution and diversity of aquatic plants and favour invasion by species such as reed grass and purple loosestrife.

Water quality in the wetland may be altered as a result of runoff from the development or due to construction activities. Increases in turbidity as a result of higher sediment and nutrient loadings may reduce the depth that sunlight penetrates into the water column. This reduces the area of the wetland that is capable of supporting aquatic submergents. As water turbidity increases, the plant community becomes less diverse, and is dominated by aggressive, pollution-tolerant species. Invertebrate and fish populations also become less diverse. These factors reduce habitat quality for staging waterfowl.

Development on adjacent lands may have major effects on staging waterfowl owing to disturbance effects. Many of the species are sensitive to human activities; this is why some of them are restricted primarily to larger water bodies and wetlands. Where the wetland is a large water body, birds may be disturbed by boats; both from developments on the shoreline and adjacent to it if there is an increase in boat traffic. This has been demonstrated to be a problem for staging waterfowl on the lower Great Lakes and other locations (Thompson 1973; Dennis and North 1985; Dennis et al. 1985; Korschgen et al. 1985; Ross 1985b; Kessel et al. 2002; Mowbray 2002). Removal of adjacent land cover may result in visual disturbance as many waterfowl species prefer seclusion.

Pease et al. (2005) studied the impacts of various types of disturbance on waterfowl in Virginia. They found that response of ducks was variable depending upon the type of disturbance, species of duck, and distance from disturbance. People walking and biking disturbed ducks more than vehicles did. American Wigeon, Green-winged Teal, and Gadwall were most sensitive, while Northern Pintail was least sensitive. It may be necessary to conduct site-specific studies on impacts of human disturbance on staging waterfowl when planning development.

Development on cropland adjacent to wetlands may also reduce the function of the marsh for supporting staging waterfowl. Certain of the species tend to rely on corn and other grains during autumn migration. This is usually a concern only with fields that are adjacent to marshes larger than 20 ha.

Mitigation Options

The area of the flooded field ecosite plus a 100-300 m radius area (dependent on local site conditions and adjacent land use) is the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

If development is to occur in wetlands it may not be possible to mitigate its effects on the function of the remaining wetland as a significant waterfowl staging area. Development must be planned to ensure that marsh area is not greatly reduced, particularly to the point where the marsh is incapable of supporting the most sensitive species present.

Development within a wetland can greatly affect hydrology and therefore plant communities within the wetland. Development will reduce the storage area of the wetland. If the same watershed is maintained, water levels are likely to increase, thereby reducing the extent of vegetation within the marsh. A water balance study should be conducted for any development proposed within a wetland to ensure no negative effects to the significant wildlife habitat.

Adjacent land development can be benign provided care is taken to ensure that water levels or water quality do not change and that it is designed in such a manner that subsequent human activities are not too disturbing. Hydrological studies will be required to predict changes in water levels and the duration, magnitude, and frequency of water-level fluctuations. If the wetland receives groundwater inputs, it needs to be demonstrated that development will not alter the amount of groundwater reaching the wetland. Appropriate stormwater management will be required to ensure that an excess of sediments or nutrients does not reach the wetland. A water and nutrient balance may be required to demonstrate that there will be no impact on wetland functions.

For certain species, it may be necessary to control human activities. For the most sensitive species, large-scale development near the staging area may not be compatible. Development must be designed so as not to promote or encourage increased use of the wetland. For example, no roads should be built right to the wetland, and all natural vegetation needs to be left between the development and the wetland.

In some cases, it may be possible to expand the wetland. This type of mitigation should never be planned as a trade-off for destroying some of the original wetland. Proponents wishing to enhance wetland functions or size should refer to the Temperate Wetland Restoration Guidelines (Mansell et al. 1998).

In some instances, it may be necessary to maintain active agricultural land adjacent to a staging area to provide food for staging waterfowl. This should be necessary only when significant numbers of birds in this guild rely on this resource.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Waterfowl staging areas have the potential to be affected by golf courses and marinas.

Golf courses may be relatively benign provided they are planned so that they do not directly affect wetlands used by staging waterfowl. Potential impacts include enrichment of the wetland by fertilizers and changes in water levels due to re-grading activities and irrigation.

Marinas are most likely to have indirect effects as a result of increased boat traffic in larger water bodies that are used by staging waterfowl, although there may be effects from shoreline construction, docks, and dredging.

Draining, dredging, excavating, or filling portions of wetlands to establish development will have negative impacts on the function of the wetland as a waterfowl staging area. This may result in direct habitat loss for these species. Additionally, the smaller wetland basin that will remain is likely to be subject to higher water levels due to reduced storage. The deeper water is likely to reduce the extent of aquatic submergent and emergent vegetation, which is critical to many of these species. Deeper water may also kill shrubs and trees living on hummocks in the water or along the shoreline. Some of the waterfowl species in this guild require large wetlands so that they are safe from predators and disturbance. If the wetland area is decreased, habitat may no longer be suitable for area-sensitive species.

Water quality in the wetland may be altered as a result of nutrients or pesticides from golf courses or due to construction activities.

Marina development may have major effects on staging waterfowl owing to disturbance effects. Many of the species are sensitive to human activities; this is why some of them are restricted primarily to larger water bodies and wetlands. Disturbance by boats has been demonstrated to be a problem for staging waterfowl on the lower Great Lakes and other locations (Thompson 1973; Dennis and North 1985; Dennis et al. 1985; Korschgen et al. 1985; Ross 1985b; Kessel et al. 2002; Mowbray 2002). Removal of adjacent land cover may result in visual disturbance as many waterfowl species prefer seclusion.

Mitigation Options

The area of the flooded field ecosite plus a 100-300 m radius (dependent on local site conditions and adjacent land use) is the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Golf courses need to be designed so that there are no direct impacts on wetlands used by staging waterfowl. Appropriate buffers need to be established around the significant wildlife habitat to ensure that fertilizers and sediments do not flow into the wetland. Wetlands should not be used for irrigation water unless it can be demonstrated that this will not have a negative effect on the function of the wetland to support staging waterfowl.

If development does occur in wetlands it may not be possible to mitigate its effects on the function of the remaining wetland as a significant waterfowl staging area. Development must be planned to ensure that marsh area is not greatly reduced, particularly to the point where the marsh is incapable of supporting the most sensitive species present.

A water balance study should be conducted for any development proposed within or adjacent to a wetland to ensure no negative effects to the significant wildlife habitat.

In some cases, it may be possible to expand the wetland. This type of mitigation should never be planned as a trade-off for destroying some of the original wetland. Proponents wishing to enhance wetland functions or size should refer to the Temperate Wetland Restoration Guidelines (Mansell et al. 1998).

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Pits and quarries are unlikely to be developed in significant habitat for staging waterfowl, but could potentially be developed adjacent to these habitats. Pits and quarries have the potential to affect water levels in adjacent wetlands and water bodies due to dewatering activities, excavation below the water table, and discharge of water.

Mines could affect habitat for staging waterfowl through discharge of tailings into the habitat or through declines in water levels due to dewatering activities.

Mitigation Options

The area of the flooded field ecosite plus a 100-300 m radius (dependent on local site conditions and adjacent land use) is the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

For pits, quarries, and mines, hydro-geological studies will be required to determine impacts of resource extraction on water levels of water bodies and wetlands that provide significant habitat for staging waterfowl. If water levels are likely to decline, this may be mitigated by limiting the depth of extraction, creating impermeable barrier or recharge wells (although this technology has yet to be tested for its efficacy), and possible by pumping water. If water is going to be pumped to the water body or wetland, it needs to be treated prior to discharge to remove sediments and contaminants so there is no negative effect on the habitat.

Mine tailings should not be directed toward significant waterfowl staging areas, otherwise a negative effect to the significant wildlife habitat may occur.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Wind energy projects have the potential to adversely affect birds through direct fatalities, disturbance, and habitat loss (Kingsley and Whittam 2005; Environment Canada 2007a). With a few important exceptions (e.g., raptors in California), avian fatalities at wind power facilities tend to be low relative to other anthropogenic mortality factors (Kingsley and Whittam 2005). Collisions occur mainly at sites where there are unusual concentrations of birds (e.g., migration corridors) and wind turbines, or where the behaviour of birds puts them at risk (e.g., aerial courtship displaying) (Arcus Renewable Energy Consulting Ltd. 2007).

Greater adverse effects from wind power facility development result from disturbance and habitat loss (Kingsley and Whittam 2005).

Shoreline and offshore areas are attractive locations for wind power facilities due to the frequency and velocity of winds. Islands and shorelines represent important habitat for large populations of birds. There is potential for wind power facilities to be constructed in the lower Great Lakes. Turbine noise, the physical movement of turbines during operation, and human activities associated with turbine maintenance may disturb staging birds.

When situated on islands or on shorelines, wind power developments have the potential to result in avoidance responses by waterfowl. In Denmark, two separate studies showed that diving ducks avoided an offshore wind power development, particularly in poor weather (Kingsley and Whittam 2005). Where this impact occurs, important aquatic and field feeding areas may become inaccessible to staging birds. Additionally, turbines may intercept movement of waterfowl from aquatic feeding areas to field feeding areas. Thus there is the potential for direct mortality of birds due to collision with turbine blades. For example, in the Netherlands where turbines are often sited near coastal areas, estimates of collision rates have been as high as 37 birds per turbine per year (Winkelman 1994, in West, Inc. 2001). Negative impacts on birds using a staging area will, in turn, have a negative impact on the habitat itself by reducing its ecological function.

To date, there is relatively little known about the potential impacts of wind power facilities on waterfowl in Ontario, but new information is being collected annually. James (2003) studied the impacts of a single turbine on birds at Pickering. He found no mortality of waterfowl, and Canada Geese, swans, Mallards, Gadwall, and Blue-winged Teal appeared to be unaffected by the presence of the turbine. They exhibited no evident behavioural response to the turbine. James (2008) also noted no response of Canada Geese or Mallards to a wind farm on the shore of Lake Erie.

The two studies by James (2003, 2008) are very instructive, but did not encounter some of the conditions that may be most critical to waterfowl. These include turbines that are constructed offshore in the Great Lakes, those that are near very high concentrations of staging waterfowl, and those that are in areas where waterfowl travel regularly inland to forage in agricultural fields.

Kuvlesky et al. (2007) summarized European experiences regarding the effects of wind power facilities on waterfowl. Collision rates for waterfowl are often higher in wind power facilities located offshore than those that are on shore. Offshore wind power facilities were found to divert migration routes of sea ducks from those traditionally followed, but the impacts of this on populations was unclear. Other studies have demonstrated that wind power facilities displaced or diverted migration of waterfowl and shorebirds. Some post-construction monitoring of European wind power facilities has documented fewer waterfowl entering a wind farm area after construction compared with baseline conditions. Drewitt and Langston (2006) believed that the presence of offshore wind power facilities could discourage bird use of areas as far as 800 m from a site, although they acknowledged that 600 m was a more widely accepted distance. These authors also stated that large birds with poor maneuverability, such as geese and swans, are generally at greater risk of collision with turbine blades, as are species that habitually fly at dawn or dusk (such as waterfowl) as they are potentially less likely to detect and avoid turbines.

Mitigation Options: Wind Power Facilities

The area of the flooded field ecosite plus a 100-300 m radius (dependent on local site conditions and adjacent land use) is the SWH.

No renewable energy project may be developed within or expanded into a significant waterfowl staging area in a provincially significant southern or coastal wetland (O.Reg. 37.1 and 37.2). The siting of wind turbines within 120 m of waterfowl staging SWH in a provincially significant northern wetland or elsewhere should be avoided. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on waterfowl staging habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Turbine-related waterfowl mortality is highest where wind power developments occur near water (West, Inc. 2001). Currently, the best way to minimize collision mortality is to site wind power facilities in areas with low bird use (West, Inc. 2001).

Wind power facilities should be located where they will not act as a barrier to waterfowl moving into staging areas during a migratory stopover, or moving between staging areas and inland feeding fields. The careful siting of turbines can mitigate impacts related to habitat loss for species that respond to these types of developments by avoiding them.

To avoid disturbance effects, construction and regular maintenance activities should be scheduled to occur when the SWH is not being used by staging waterfowl. If post-construction monitoring indicates that a wind power facility is resulting in avoidance behaviour or excessive mortality, consideration should be given to shutting down the responsible turbines during the staging period.

Potential Development Effects: Solar Power Facilities

Draining, dredging, excavating, or filling portions of wetlands to establish development will have negative impacts on the function of the wetland as a waterfowl staging area. This may result in direct habitat loss for these species. Additionally, the smaller wetland basin that will remain is likely to be subject to higher water levels due to reduced storage. The deeper water is likely to reduce the extent of aquatic submergent and emergent vegetation, which is critical to many of these species. Deeper water may also kill shrubs and trees living on hummocks in the water or along the shoreline. Some of the waterfowl species in this guild require large wetlands so that they are safe from predators and disturbance. If the wetland area is decreased, habitat may no longer be suitable for area-sensitive species.

Changes to water levels may result from adjacent development. Because many migrating waterfowl species have specific vegetation density or species requirements, they will abandon sites when vegetation cover becomes too sparse or dense, or if dominant species change. Changes in the ratio of emergent cover to open water may also affect habitat quality for many species. If significant areas of marshland vegetation are affected, then the marsh may cease to function as waterfowl staging habitat.

Water levels may increase if a significant portion of the wetland's watershed is hardened resulting in a higher percentage of precipitation being directed to the wetland. Diversion of water by development may also increase the watershed area. Higher water levels will result in less aquatic vegetation and more open water. This may make the habitat unsuitable for certain species, particularly those that prefer extensive stands of emergents or prefer shallow water. Deeper water may enhance conditions for species that prefer submergents, at the expense of those that require emergents.

Development may also change the frequency, duration, and magnitude of water-level fluctuations through creation of impervious areas. Unnatural water-level fluctuations may affect distribution and diversity of aquatic plants and favour invasion by species such as reed grass and purple loosestrife.

Water quality in the wetland may be altered as a result of runoff from the development or due to construction activities. Increases in turbidity as a result of higher sediment and nutrient loadings may reduce the depth that sunlight penetrates into the water column. This reduces the area of the wetland that is capable of supporting aquatic submergents. As water turbidity increases, the plant community becomes less diverse, and is dominated by aggressive, pollution-tolerant species. Invertebrate and fish populations also become less diverse. These factors reduce habitat quality for staging waterfowl.

Development on adjacent lands may have major effects on staging waterfowl owing to disturbance effects. Many of the species are sensitive to human activities; this is why some of them are restricted primarily to larger water bodies and wetlands. Removal of adjacent land cover may result in visual disturbance as many waterfowl species prefer seclusion.

Pease et al. (2005) studied the impacts of various types of disturbance on waterfowl in Virginia. They found that response of ducks was variable depending upon the type of disturbance, species of duck, and distance from disturbance. People on foot disturbed ducks more than vehicles did. American Wigeon, Green-winged Teal, and Gadwall were most sensitive, while Northern Pintail was least sensitive. It may be necessary to conduct site-specific studies on impacts of human disturbance on staging waterfowl when planning development.

Development on cropland adjacent to wetlands may also reduce the function of the marsh for supporting staging waterfowl. Certain of the species tend to rely on corn and other grains during autumn migration. This is usually a concern only with fields that are adjacent to marshes larger than 20 ha.

Mitigation Options: Solar Power Facilities

The area of the flooded field ecosite plus a 100-300 m radius (dependent on local site conditions and adjacent land use) is the SWH.

No renewable energy project may be developed within or expanded into a significant waterfowl staging area in a provincially significant southern or coastal wetland (O.Reg. 37.1 and 37.2). The siting of solar panel arrays within 120 m of the outer edge of any ELC ecosite that contains waterfowl staging SWH in a provincially significant northern wetland or elsewhere should be avoided. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

If development is to occur in wetlands it may not be possible to mitigate its effects on the function of the remaining wetland as a significant waterfowl staging area. Development must be planned to ensure that marsh area is not greatly reduced, particularly to the point where the marsh is incapable of supporting the most sensitive species present.

Development within a wetland can greatly affect hydrology and therefore plant communities within the wetland. Development will reduce the storage area of the wetland. If the same watershed is maintained, water levels are likely to increase, thereby reducing the extent of vegetation within the marsh. A water balance study should be conducted for any development proposed within a wetland to ensure no negative effects to the significant wildlife habitat.

Adjacent land development can be benign provided care is taken to ensure that water levels or water quality do not change and that it is designed in such a manner that subsequent human activities are not too disturbing. Hydrological studies will be required to predict changes in water levels and the duration, magnitude, and frequency of water-level fluctuations. If the wetland receives groundwater inputs, it needs to be demonstrated that development will not alter the amount of groundwater reaching the wetland. Appropriate stormwater management will be required to ensure that an excess of sediments or nutrients does not reach the wetland. A water and nutrient balance study may be required to demonstrate that there will be no impact on wetland functions.

For certain species, it may be necessary to control human activities. For the most sensitive species, large-scale development near the staging area may not be compatible. Development must be designed so as not to promote or encourage increased use of the wetland. For example, no roads should be built right to the wetland, and all natural vegetation needs to be left between the development and the wetland. Schedule construction and regular maintenance activities to occur when the SWH is not being used by staging waterfowl.

In some cases, it may be possible to expand the wetland. This type of mitigation should never be planned as a trade-off for destroying some of the original wetland. Proponents wishing to enhance wetland functions or size should refer to the Temperate Wetland Restoration Guidelines (Mansell et al. 1998).

In some instances, it may be necessary to maintain active agricultural land adjacent to a staging area to provide food for staging waterfowl. This should be necessary only when significant numbers of birds in this guild rely on this resource.

ROAD DEVELOPMENT

Potential Development Effects

Roads have the potential to affect waterfowl staging areas if they are constructed through or adjacent to the staging habitat. Roads within the wetland will likely result in direct habitat loss.

Roads within or adjacent to staging wetlands may alter water quality and hydrology in the area, thus affecting plant distribution and habitat quality for waterfowl.

Mitigation Options

The area of the flooded field ecosite plus a 100-300 m radius (dependent on local site conditions and adjacent land use) is the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Wherever possible, roads need to be routed outside waterfowl stopover and staging SWH. If a road must pass through the habitat, it needs to be routed as close to the edge as possible rather than through the centre. Sufficient culverts need to be installed beneath the road to ensure that normal flow of surface water and shallow ground water is maintained.

Depending upon the sensitivity of the water quality in the wetland and the density of traffic on the road, it may be necessary to direct surface runoff from the road to stormwater management facilities prior to discharge to the wetland.

INDEX #8: SHOREBIRD MIGRATORY STOPOVER AREAS

Ecoregions:	All of Ontario
Species Group:	Greater Yellowlegs, Lesser Yellowlegs, Marbled Godwit, Hudsonian Godwit, Black-bellied Plover, American Golden-Plover, Semipalmated Plover, Solitary Sandpiper, Spotted Sandpiper, Semipalmated Sandpiper, Pectoral Sandpiper, White-rumped Sandpiper, Baird's Sandpiper, Least Sandpiper, Purple Sandpiper, Stilt Sandpiper, Short-billed Dowitcher, Red-necked Phalarope, Whimbrel, Ruddy Turnstone, Sanderling, Dunlin
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Migratory Stopover Areas
Habitat Features:	Shorelines of lakes, rivers and wetlands

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Migrating shorebirds follow shorelines or major river corridors as they move between winter and summer range. Many stop in traditionally-used areas to rest and feed before moving on. Some species use migration stopover areas much like "stepping stones" in a path between southern wintering areas and northern breeding habitat. Birds often move long distances between stopover areas. When they arrive in an area they need a safe place to rest and feed to replenish energy reserves required to continue on. Large numbers may accumulate in stopover areas during poor flying weather. Once conditions improve, the birds leave and continue their journeys. Stopover areas must be large enough to supply adequate food supplies for the many birds using the area.

The main areas of shorebird concentration in Ontario are on the coasts of Hudson and James Bays (James 1999). In spring, the birds are focused on reaching breeding areas, so flocks seldom remain any length of time. In the fall, however, hundreds of thousands stage on these northern coasts to put on weight prior to migrating farther south. Shorebirds never reach these concentrations in southern Ontario; they occur in small numbers at many different sites on shorelines, seasonally flooded fields, inland lakes and marshes, and sewage ponds (James 1999). The most significant stopover areas in southern Ontario appear to be along the southern Great Lakes shorelines, probably because of their location along migration routes and since wave action maintains a large and productive beach where food is abundant. Important stopover areas have been identified at Amherst Island, Sandbanks Provincial Park, Presqu'ile Provincial Park, marshes from Oshawa to Frenchman's Bay, Toronto harbour eastern headland, the Hamilton harbour area, Erie Beach, Long Point, the Rondeau area, the Point Pelee area including the onion fields and Hillman Marsh, and the Lake St. Clair delta and marshes including Walpole Island and the National Wildlife Area. A considerable number of observations also come from the Ottawa River (James 1999).

For an area to function as a migration stopover area for shorebirds it must provide a stretch of undisturbed shoreline in areas of relatively abundant food (insects, clams, snails, worms, etc.). Many areas are used traditionally and as such may have been selected for habitat features that are now gone or greatly reduced in abundance. Birds may continue to use areas with less than ideal habitat composition and structure simply because they have always done so or have nowhere else to go. Some stopover areas are used primarily because of their geographic position with respect to migration routes. Species which use habitat in this way are vulnerable to development and natural catastrophes which affect the stopover areas that they use since they are reluctant to move to new areas. Rather, they continue to use denuded areas and their populations decline owing in part to increased mortality associated with use of low quality habitat.

Most shorebirds have particular microhabitat requirements at migration stopover points. These include factors such as preferred foraging substrates, where they forage in relation to the water's edge, their diet, and roosting habitat. Some apparently minor alterations in habitat may make the area unsuitable for some species.

See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

The most pressing problem facing all shorebird species, both staging birds and breeders, is loss of habitat (James 1999). These birds are sensitive to factors that decrease survivorship away from the breeding grounds (Myers et al. 1987, in James 1999). In southern Ontario, stopover areas along the shorelines of the Great Lakes and major rivers could be rather critical for many species. They may be particularly important to northbound migrants heading to cold environments where food resources may still be scarce (James 1999). Threats to Ontario shorebirds identified in the Ontario Shorebird Conservation Plan (Ross et al. 2003) include urbanization, wetland loss and degradation, shoreline loss, agricultural practices, resource extraction, and hydroelectric development.

Development can have serious impacts on the function of traditional migration stopover areas for shorebirds if sizable portions of the area used by birds or particular microhabitats used by certain species are altered.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Excavation, wetland drainage, shoreline stabilization, building and lot-clearing activities which affect the nearshore area and adjacent beach will affect shorebirds. Habitat quality is reduced when beach and nearshore area plant communities and structure are simplified, or if there is a reduction in the number of substrate types available. The loss of species and structural diversity reduces the availability of food and shelter for shorebirds.

Development on adjacent land is not expected to directly affect shorebird use of traditional stopover areas provided it does not result in an increase in human activity on beaches during peak migration periods.

Any development or operation that degrades water quality may have an effect on staging shorebirds. Water quality impairment can simplify the aquatic invertebrate community, resulting in less food for shorebirds, particularly for those species that specialize in feeding on certain groups of invertebrates.

Developments which occur on or very close to sand beaches have the potential to result in significant shoreline erosion. This may occur when structures are placed on the beach or even on sand dunes behind the beach, or when structures in the water interrupt coastal drift of sand. Developments considerable distances away may result in erosion, depending on current patterns in the lake.

Increased residential development contributes to increased disturbance by people (e.g., greater recreational use of shorelines), and their cats and dogs. Several studies have been completed on the responses of shorebirds to human disturbance.

Trulio and Sokale (2008) examined how shorebirds responded to trail use around San Francisco Bay. They concluded that motorized or other high-speed, high-noise activities be excluded from shorebird staging areas and that managers provide substantial, high-quality areas for shorebirds that are not adjacent to trails to offer birds alternative, undisturbed areas for foraging and other activities.

Thomas et al. (2003) found that the number and activity of people significantly reduced the amount of time that Sanderlings spent foraging. The most significant negative impact was the presence of free-running dogs on the beach. They recommended that humans maintain a minimum distance of 30 m from areas where shorebirds concentrate and that leash laws be strictly enforced. Pfister et al. (1992) found that the effects of human disturbance on staging shorebirds could be reduced or perhaps eliminated by closing one or more small portions of the front beach as refuge resting areas during migration. Burton et al. (1996) found that increases in disturbance due to pedestrians and also to boat traffic resulted in significant declines in numbers of staging shorebirds.

The general conclusions that may be drawn are that human disturbance can have a significant effect on shorebird usage of a staging area. Dogs may be a greater problem than humans in disturbing shorebirds, and the reaction of shorebirds may be species-specific.

Mitigation Options

The area of significant shorebird migratory stopover habitat includes the mapped ELC shoreline ecosites plus a 100 m radius area. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Developments like estate residential or cottage neighbourhoods typically involve major changes to shoreline areas. It may not be possible to mitigate these impacts if site alterations occur in areas traditionally used by migrating shorebirds. For significant shorebird stopover areas, the entire shoreline should be protected unless an Impact Assessment can demonstrate that development of portions of it will not have negative impacts on migrating shorebirds. The impacts of shoreline alteration and the resulting loss of function cannot be rehabilitated or compensated.

Development on adjacent land needs to be set back from the shoreline so that buildings and human activity are not visible from the beach. Trees may be planted to establish a visual barrier and reduce the noise associated with human activity, provided that trees will not impair shorebird habitat or discourage shorebird usage of the area.

During peak migration periods of sensitive species, it may be necessary to implement measures to control human access to the shoreline. This includes timing construction activities to avoid these periods. Portions or all of the area may have to be closed to human usage during peak staging periods. If humans are permitted, their usage of the site needs to be managed. It may be useful to establish a trail system so that the movement of humans can be directed away from key areas while allowing access at the same time. Motorized vehicles and dogs and other pets should not be allowed within the habitat; it is very important that all of these regulations be strictly controlled. Activities such as raking the beach to make it more attractive to humans should not be allowed or a negative effect to the habitat may occur. The vegetation that drifts up on the shoreline is an important source of food for many species. When managing for human activities, it may be necessary to conduct studies in advance to determine the response of the various species present to different intensities and types of activities.

Sediment control will also be necessary during construction, and appropriate stormwater management measures will have to be implemented to ensure that water quality is not impaired in the vicinity of the shoreline. It may be possible to design stormwater management ponds so they provide some shorebird stopover habitat (i.e. gentle slopes, sand or mud substrates). These habitats, however, in no way would compensate for the loss of an important natural area. Stormwater ponds should always be additive as opposed to compensatory. Stormwater ponds also have the potential to have elevated levels of environmental contaminants which may pose a risk to migrating shorebirds.

For developments that are close to the water's edge, it may be necessary to conduct coastal engineering studies to ensure that there will be no erosion of the beach.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Recreational parks, beaches, marinas, and golf courses all have the potential to affect shorebird staging habitat. The latter type of development is unlikely to be proposed directly in shorebird staging habitat, but the other types may occur on shorelines.

Excavation, wetland drainage, shoreline stabilization, and building activities which affect the nearshore area and adjacent beach will affect shorebirds. Habitat quality is reduced when beach and nearshore area plant communities and structure are simplified, or if there is a reduction in the number of substrate types available. The loss of species and structural diversity reduces the availability of food and shelter for shorebirds.

Development on adjacent land is not expected to directly affect shorebird use of traditional stopover areas provided it does not result in an increase in human activity on beaches during peak migration periods.

Golf courses have the potential to degrade water quality through inputs of nutrients or pesticides, and this may have an effect on staging shorebirds. Water quality impairment can simplify the aquatic invertebrate community, resulting in less food for shorebirds, particularly for those species that specialize in feeding on certain groups of invertebrates.

Developments which occur on or very close to sand beaches have the potential to result in significant shoreline erosion. This may occur when structures are placed on the beach or even on sand dunes behind the beach, or when structures in the water interrupt coastal drift of sand. Developments considerable distances away may result in erosion, depending on current patterns in the lake.

Recreational developments such as shoreline parks and marinas may contribute to increased disturbance by people (e.g., recreational use of shorelines), and their dogs. Several studies have been completed on the responses of shorebirds to human disturbance.

Trulio and Sokale (2008) examined how shorebirds responded to trail use around San Francisco Bay. They concluded that motorized or other high-speed, high-noise activities be excluded from shorebird staging areas and that managers provide substantial, high-quality areas for shorebirds that are not adjacent to trails to offer birds alternative, undisturbed areas for foraging and other activities.

Thomas et al. (2003) found that the number and activity of people significantly reduced the amount of time that Sanderlings spent foraging. The most significant negative impact was the presence of free-running dogs on the beach. They recommended that humans maintain a minimum distance of 30 m from areas where shorebirds concentrate and that leash laws should be strictly enforced. Pfister et al. (1992) found that the effects of human disturbance on staging shorebirds could be reduced or perhaps eliminated by closing one or more small portions of the front beach as refuge resting areas during migration. Burton et al. (1996) found that increases in disturbance due to pedestrians and also to boat traffic resulted in significant declines in numbers of staging shorebirds.

The general conclusions that may be drawn are that human disturbance can have a significant effect on shorebird usage of a staging area. Dogs may be a greater problem than humans in disturbing shorebirds, and the reaction of shorebirds may be species-specific.

Mitigation Options

The area of significant shorebird migratory stopover habitat includes the mapped ELC shoreline ecosites plus a 100 m radius area. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

The effects of developments like marinas or resorts which involve major changes to shoreline areas may not be able to be mitigated if site alterations occur in areas traditionally used by migrating shorebirds. Traditional shorebird migration stopover areas should be avoided. For significant shorebird stopover areas, the entire shoreline needs to be protected unless an Impact Assessment can demonstrate that development of portions of it will not have negative impacts on migrating shorebirds. The impacts of shoreline alteration and the resulting loss of function cannot be rehabilitated or compensated.

Development on adjacent land needs to be set back a minimum of 30 m from the shoreline so that buildings and human activity are not visible from the beach. Trees may be planted to establish a visual barrier and reduce the noise associated with human activity, provided that trees will not impair shorebird habitat or discourage shorebird usage of the area.

Sediment control will also be necessary during construction, and appropriate stormwater management measures will have to be implemented to ensure that water quality is not impaired in the vicinity of the shoreline. It may be possible to design stormwater management ponds so they provide some shorebird stopover habitat (i.e. gentle slopes, sand or mud substrates). These habitats, however, in no way would compensate for the loss of an important natural area. Stormwater ponds should always be additive as opposed to compensatory. Stormwater ponds also have the potential to have elevated levels of environmental contaminants which may pose a risk to migrating shorebirds.

Golf course runoff should not be directed to shorebird staging habitat unless there are sufficient buffers or stormwater management treatment facilities to ensure that excessive nutrients and pesticides do not reach the wetland.

For developments that are close to the water's edge, it may be necessary to conduct coastal engineering studies to ensure that there will be no erosion of the beach.

During peak migration periods of sensitive species, it may be necessary to implement measures to control human access to the shoreline. This includes timing construction activities to avoid these periods. Portions or all of the area may have to be closed to human usage during peak staging periods. If humans are permitted, their usage of the site should be managed. It may be useful to establish a trail system so that the movement of humans can be directed away from key areas while allowing access at the same time. Motorized vehicles and dogs and other pets should not be allowed within the habitat; it is very important that all of these regulations be strictly controlled. Activities such as raking the beach to make it more attractive to humans should not be allowed or a negative effect to the habitat may occur. The vegetation that drifts up on the shoreline is an important source of food for many species. When managing for human activities, it may be necessary to conduct studies in advance to determine the response of the various species present to different intensities and types of activities.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

It is unlikely that aggregate or mine development would be proposed in significant shorebird staging areas, but there is potential for them to occur adjacent to this habitat. Pits and quarries have the potential to affect water levels in adjacent wetlands and water bodies due to dewatering activities, excavation below the water table, and discharge of water.

Mines could affect habitat for staging shorebirds through discharge of tailings into the habitat or through declines in water levels due to dewatering activities.

Mitigation Options

The area of significant shorebird migratory stopover habitat includes the mapped ELC shoreline ecosites plus a 100 m radius area. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNR 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

For pits, quarries, and mines, hydro-geological studies will be required to determine impacts of resource extraction on water levels of water bodies and wetlands that provide significant wildlife habitat for staging shorebirds. If water levels are likely to decline, this may be mitigated by limiting the depth of extraction, creating impermeable barrier or recharge wells (although this technology has yet to be tested for its efficacy), and possible by pumping water. If water is going to be pumped to the water body or wetland, it should be treated prior to discharge to remove sediments and contaminants; otherwise a negative effect on the habitat may occur.

Mine tailings should never be directed toward significant shorebird staging areas.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Wind energy projects have the potential to adversely affect birds through direct fatalities, disturbance, and habitat loss (Kingsley and Whittam 2005; Environment Canada 2007a). With a few important exceptions (e.g., raptors in California), avian fatalities at wind power facilities tend to be low relative to other anthropogenic mortality factors (Kingsley and Whittam 2005). Collisions occur mainly at sites where there are unusual concentrations of birds (e.g., migration corridors) and wind turbines, or where the behaviour of birds puts them at risk (e.g., aerial courtship displaying) (Arcus Renewable Energy Consulting Ltd. 2007). Greater adverse effects from wind power facility development result from disturbance and habitat loss (Kingsley and Whittam 2005).

The northern coasts and Great Lakes shorelines have high potential for wind power facility development and also support the most significant shorebird staging areas in the province. Offshore wind power facilities have also been proposed in the lower Great Lakes. Even wind power facilities located in agricultural settings may have potential effects on shorebird staging, as wet fields in certain areas of southwestern Ontario may be locally important for staging.

Potential impacts of wind power facilities on staging shorebirds are disturbance, avoidance of the area of the turbines, and direct mortality due to being struck by turbine blades. When these impacts affect bird use of the staging habitat, or reduce the survival of birds that continue to use the habitat, the ecological function of that habitat is also reduced.

Some studies show that shorebirds avoid turbines up to 500 m distant while others show no significant effect on shorebird distribution (Kingsley and Whittam 2005). Different shorebird species may have different thresholds for disturbance, and conditions in the surrounding landscape may also influence how the birds react. For example, if there is an abundance of suitable habitat near the project site, shorebirds may be more likely to move away from the turbines. If habitat is limited, birds may not have the option of relocating and therefore will remain in close proximity to the turbines (Landscape Design Associates 2000).

Shorebirds will probably be most affected by offshore turbines acting as a barrier to seasonal and local migrations (Exo et al. 2003). Other potential adverse effects include changes in the sedimentation pattern and forage species composition (Percival 2001, in Kingsley and Whittam 2005). Even if a wind facility is located well offshore, it may possibly have a negative effect upon shorebirds that forage along the shoreline if changes in sedimentation pattern change the composition of mud (or other substrate) along the shore, which could affect availability or abundance of food supply.

Collision mortality for shorebirds has been reported in a number of studies (USA, Netherlands, Germany, Belgium, United Kingdom), but the total number of carcasses is small (Kingsley and Whittam 2005).

Mitigation Options: Wind Power Facilities

The area of significant shorebird migratory stopover habitat includes the mapped ELC shoreline ecosites plus a 100 m radius area.

The siting of wind turbines within 120 m of the outer edge of any ELC ecosite that contains significant shorebird migratory stopover habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on shorebird stopover habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

To avoid disturbance effects, construction and regular maintenance activities should be scheduled to occur when the SWH is not being used by staging shorebirds. If post-construction monitoring indicates that a wind power facility is resulting in avoidance behaviour or excessive mortality, consideration should be given to shutting down the responsible turbines during the staging period.

Potential Development Effects: Solar Power Facilities

Excavation, wetland drainage, shoreline stabilization, building and lot-clearing activities which affect the nearshore area and adjacent beach will affect shorebirds. Habitat quality is reduced when beach and nearshore area plant communities and structure are simplified, or if there is a reduction in the number of substrate types available. The loss of species and structural diversity reduces the availability of food and shelter for shorebirds.

Development on adjacent land is not expected to directly affect shorebird use of traditional stopover areas provided it does not result in an increase in human activity on beaches during peak migration periods.

Any development or operation that degrades water quality may have an effect on staging shorebirds. Water quality impairment can simplify the aquatic invertebrate community, resulting in less food for shorebirds, particularly for those species that specialize in feeding on certain groups of invertebrates.

Developments which occur on or very close to sand beaches have the potential to result in significant shoreline erosion. This may occur when structures are placed on the beach or even on sand dunes behind the beach, or when structures in the water interrupt coastal drift of sand. Developments considerable distances away may result in erosion, depending on current patterns in the lake.

Increased residential development contributes to increased disturbance by people (e.g., greater recreational use of shorelines), and their cats and dogs. Several studies have been completed on the responses of shorebirds to human disturbance.

Trulio and Sokale (2008) examined how shorebirds responded to trail use around San Francisco Bay. They concluded that motorized or other high-speed, high-noise activities be excluded from shorebird staging areas and that managers provide substantial, high-quality areas for shorebirds that are not adjacent to trails to offer birds alternative, undisturbed areas for foraging and other activities.

Thomas et al. (2003) found that the number and activity of people significantly reduced the amount of time that Sanderlings spent foraging. The most significant negative impact was the presence of free-running dogs on the beach. They recommended that humans maintain a minimum distance of 30 m from areas where shorebirds concentrate and that leash laws be strictly enforced. Pfister et al. (1992) found that the effects of human disturbance on staging shorebirds could be reduced or perhaps eliminated by closing one or more small portions of the front beach as refuge resting areas during migration. Burton et al. (1996) found that increases in disturbance due to pedestrians and also to boat traffic resulted in significant declines in numbers of staging shorebirds.

The general conclusions that may be drawn are that human disturbance can have a significant effect on shorebird usage of a staging area. Dogs may be a greater problem than humans in disturbing shorebirds, and the reaction of shorebirds may be species-specific.

Mitigation Options: Solar Power Facilities

The area of significant shorebird migratory stopover habitat includes the mapped ELC shoreline ecosites plus a 100 m radius area.

The siting of solar panel arrays within 120 m of shorebird migratory stopover SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally an important component of any successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on waterfowl staging habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development in or immediately adjacent to shorebird migratory staging habitat will damage or destroy the habitat. It may not be possible to mitigate these impacts. For significant shorebird stopover areas, the entire shoreline should be protected unless an Impact Assessment can demonstrate that development of portions of it will not have negative impacts on migrating shorebirds. The impacts of shoreline alteration and the resulting loss of function cannot be rehabilitated or compensated.

Development on adjacent land needs to be set back from the shoreline so that buildings and human activity are not visible from the beach. Trees and/or tall shrubs may be planted to establish a visual barrier and reduce the noise associated with human activity, provided that trees will not impair shorebird habitat or discourage shorebird usage of the area.

Schedule construction and regular maintenance activities to occur when birds are not using the habitat. Sediment control will also be necessary during construction, and appropriate stormwater management measures will have to be implemented to ensure that water quality is not impaired in the vicinity of the shoreline.

It may be possible to design stormwater management ponds so they provide some shorebird stopover habitat (i.e. gentle slopes, sand or mud substrates). These habitats, however, in no way would compensate for the loss of an important natural area. Stormwater ponds should always be additive as opposed to compensatory. Stormwater ponds also have the potential to have elevated levels of environmental contaminants which may pose a risk to migrating shorebirds.

For developments that are close to the water's edge, it may be necessary to conduct coastal engineering studies to ensure that there will be no erosion of the beach.

ROAD DEVELOPMENT

Potential Development Effects

Roads are unlikely to be built in shorebird staging areas, as these areas tend to have shifting and wet substrates that are unsuitable for road construction. It is possible that a road could be constructed near shorebird staging areas. In this event, the road would have the potential to change the water quality and quantity in the wetland.

Mitigation Options

The area of significant shorebird migratory stopover habitat includes the mapped ELC shoreline ecosites plus a 100 m radius area. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Roads need to be set back a minimum of 30 m from shorebird staging areas to minimize disturbance. Sufficient culverts should be installed under the road to ensure free passage of surface water and shallow groundwater. If the road is likely to deliver unacceptable levels of sediments, nutrients, or contaminants to the wetland or water body, runoff from the road should be treated in stormwater management facilities prior to discharge.

INDEX #9: LANDBIRD MIGRATORY STOPOVER AREAS

Ecoregions:	6E, 7E
Species Group:	All Migrant Landbirds
Significant Wildlife Habitat Category:	Seasonal Concentration Areas
Functional Habitat:	Migratory Route/Stopover Areas
Habitat Features:	Woodlands on peninsulas or points, or with north-south orientation along the shore, and located within 5 km of Lake Ontario and Lake Erie

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Open water shorelines on large lakes, especially the Great Lakes, provide natural migratory routes and staging areas for migrating landbirds. Crossing large open bodies of water is hazardous for most small birds and many are reluctant to cross unless weather conditions are favourable (fair weather providing tail winds). Many birds opt to cross large bodies of water at narrow spots (i.e., Point Pelee, in the Niagara area, Wolf Island, etc.) (Diehl et al. 2003). Large numbers of migrating birds often stop to rest, feed and/or wait out poor weather in shoreline areas of the Great Lakes.

Many migrant birds follow shorelines as a means of navigating during migration. During spring migration, birds tend to migrate in a direction that is parallel with the northern shorelines of Lake Erie and Lake Ontario (Diehl et al. 2003). Small birds usually stop to feed and rest as they migrate. Shorelines along major migration routes which present a variety of bird habitat are important in ensuring that migrating birds are able to make their trips as efficiently as possible. These areas are important for migrating birds that need to replenish their energy reserves before continuing with their migration. Additionally, these areas are of value to migrating butterflies.

The structure and composition of habitats distributed along shoreline migration routes and particularly in traditional migration stopover areas are important to the maintenance of the area's migration function. A diversity of habitat types ranging from open grasslands to large stands of mature forests is required along shoreline migration routes (Simons et al. 2000). Petit (2000) stated that birds generally selected the same macrohabitats during migration as during the breeding season, so it is important that an area have a wide range of habitats to fully function as a migratory stopover area. He stated that large tracts of structurally diverse forest, natural representation and distribution of habitats within landscapes, and sites adjacent to geographic barriers (e.g., large bodies of water, mountain ranges) should be of high priority for conservation of migratory bird stopover habitat. Shrubby areas may be particularly attractive to migrating landbirds as they provide dense cover and an abundance of insects. In certain areas, the hatch of midges from the Great Lakes may provide an important source of food for certain species such as the Black-throated Green Warbler (Smith et al. 1998, 2007).

Geography may dictate the use of shoreline and other areas used as migration stopover areas more strongly than habitat structure and composition (Heglund and Skagen 2005). This is not to say that habitat does not matter. It means that land forms and migration traditions combine to result in large numbers of birds concentrating in shoreline areas waiting for favourable flying conditions before venturing across large water bodies or resting after crossing. Ideally, migration stopover areas should offer large areas of a variety of undisturbed habitat types. This configuration would provide a mix of habitat types for a diverse assemblage of migrating birds each having different habitat requirements. Under these conditions, many different species of birds can rest safely and forage profitably.

Ideally there should be a continuous supply of natural forest and open land within 5 km of the Great Lakes. This is particularly true for Lake Ontario and Lake Erie which have an east-west orientation. Forested habitat is especially important. It provides roosting areas, cover from predators, and food for most migrating species. Forest cover along watercourses is particularly valuable, as many birds require water while migrating. Forested ravines running north and south also allow birds to move leisurely during the day while supplementing their energy with food found within these habitats (Skagen et al. 2005). Old-field areas and weedy fields are important to some seed-eating species such as sparrows and finches.

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Multi-lot residential/cottage and commercial developments have the potential to reduce or eliminate the function of an area as a migratory stopover owing to the relatively large areas impacted.

Tree cutting and other lot-clearing activities which reduce the density of foliage and simplify forest structure will affect the quality of habitat for migrating birds. Different species of birds forage at different heights within a forest. Some hunt for food on the ground, others forage in the shrub layer while others glean insects from high in the canopy. As vertical structure is lost, fewer species of forest birds are able to forage efficiently in the remaining habitat (Barrow et al. 2000). Since large numbers of different species of birds concentrate in migratory stopover areas, it is important that the structural complexity of forests be maintained.

If the total amount of natural area (forest, old fields, and wetlands) is reduced below a minimum amount, the areas may no longer be suitable for migrating birds; alternatively, the birds may be forced into smaller areas making them more vulnerable to predation and other mortality. Food resources may also become depleted if large numbers of birds are concentrated in small areas.

Habitats within 5 km of the Great Lakes (especially Ontario and Erie) are of great value to migrating birds. Development on land adjacent to shoreline habitat in this zone is not expected to affect the function of migratory stopover areas provided that erected structures do not act as a barrier to movement (e.g., high-rise office towers may cause considerable mortality among migrating birds) or have light sources that attract birds at night.

Negative impacts on birds entering or using a stopover will, in turn, have a negative impact on the habitat itself by reducing its ecological function as a migratory stopover. In a recent analysis of incidental take due to buildings in Canada, Wedeles (2010) estimated the number of birds killed each year by residential and commercial/institutional structures. Bird mortality associated with residential structures in Ontario ranges from 1.46 – 5.33 birds per year per structure; for commercial/institutional structures, mortality ranges from 1 – 28 birds per year per structure.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Woodlots need to be >10 ha in size (in Ecoregion 6E) or >5 ha in size (in Ecoregion 7E), and within 5 km of Lake Ontario or Erie to be SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Basic principles for retaining the functions of migratory stopovers are:

1. Minimize the loss and disruption of forest cover (i.e., cluster development where possible);

2. Ensure that development does not completely sever access routes; and

3. Ensure that each area retains a good variety of habitat types.

Large natural areas with plenty of structure are very important to migrating birds. Therefore, development needs to be planned so that as much forest and undisturbed open habitat is maintained as possible.

Post-construction mitigation can include restoring the "naturalness" of vegetation by establishing areas of herbaceous plants, shrubs, and trees. Planting berry-producing trees and shrubs may be useful for sites that attract autumn migrants, and patches of native wildflowers will also be attractive to sparrows and finches. Tree and shrub cover is important in areas where spring migrants rest after crossing the lakes. Migrating birds tend not to be as affected by human disturbance as they are attracted to an area by food and cover. It may not be possible to mitigate impacts where lot-clearing in migratory stopover habitat has been extensive.

Development should be planned so that construction and related human activity is concentrated in as small an area as possible. Large areas of continuous forest cover need to be avoided for development or, if used, should only be developed at the edge rather than in the interior.

For multi-storey buildings planned in or adjacent to landbird migratory stopovers, there are mitigation measures that may be used to reduce the incidence of bird strikes. Bird strikes occur at night when birds are attracted to lights (Evans Ogden 1996), and also during the day when reflections in windows make it appear that there is no barrier to flight present.

Nocturnal bird strikes may be reduced through design of the building and an appropriate lighting plan. If possible, buildings should be designed so that there are no hallways or stairwells that have external windows. This reduces the number of windows that have lights showing all night. Balconies should be designed so that the railing and area below it is opaque so that the area of window that is visible is minimized. Blinds and curtains should be installed inside to further reduce the amount of light that is visible from the outside.

External lights should be hooded so that they do not shine upwards where they could attract birds in flight. Use of floodlights should be restricted in areas that are important bird stopover areas. Floodlights should not be situated so that they shine into the air or on the face of the building. Low-level and relatively low-power floodlights that are required to illuminate signs may be acceptable it they do not shine up into the air.

The peak of bird migration is around midnight. Apartment buildings tend to be relatively low risk to migratory birds as there are usually not many lights on during the peak flight period. Tenants should be made aware that they can help reduce the incidence of bird strikes by closing their curtains or blinds when they have the lights on at night during the migration period.

Office towers are the greatest risk to nocturnal migrants as large blocks of lights are frequently left on. These lights attract the birds that may either strike the building or fly around it until they are exhausted. Ideally, all lights would be turned off at night. If it is not feasible to turn the lights off, blinds or other materials should be installed so that lights do not shine through the windows in high-risk areas for migrating birds. In some offices, automated timers have been installed to reduce the length of time that lights are on at night (Evans Ogden 2002).

To reduce the incidence of daytime bird strikes, thought should be given to installing low-reflective glass in windows. These more opaque and typically coloured glasses are visible to birds thereby greatly reducing the potential for bird strikes. However, use of drapes and other materials that cover some or part of the window is very effective in reducing bird strikes. Adding silhouettes of falcons in windows is partially effective, but Klem (1990) found that complete or partial covering of windows will eliminate day-time bird strikes. Covering the exterior of windows with netting also prevents birds from striking windows (Klem 1991).

Shrubs or other features (e.g., feeders, bird baths) that may attract birds should be located either within 1 m or farther than 10 m from a window. This will reduce the incidence of bird mortality due to strikes (Evans Ogden 1996).

Evans Ogden (1996) stated that it is simple to prevent bird collisions with buildings: by night, turn out the lights; by day, make windows visible to birds. These principles should be taken into account when planning new buildings in or adjacent to habitat for migrating birds.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Landbird migratory stopover areas may be affected by golf courses and marinas.

Tree cutting which reduces the density of foliage and simplify forest structure will affect the quality of habitat for migrating birds. Different species of birds forage at different heights within a forest. Some hunt for food on the ground, others forage in the shrub layer while others glean insects from high in the canopy. As vertical structure is lost, fewer species of forest birds are able to forage efficiently in the remaining habitat (Barrow et al. 2000). Since large numbers of different species of birds concentrate in migration stopover areas, it is important that the structural complexity of forests be maintained.

If the total amount of natural area (forest, old fields, and wetlands) is reduced below a minimum amount, the areas may no longer be suitable for migrating birds; alternatively, the birds may be forced into smaller areas making them more vulnerable to predation and other mortality. Food resources may also become depleted if large numbers of birds are concentrated in small areas.

Negative impacts on birds entering or using a stopover will, in turn, have a negative impact on the habitat itself by reducing its ecological function as a migratory stopover. In a recent analysis of avian incidental take due to buildings in Canada, Wedeles (2010) estimated the number of birds killed each year by various types of structures. Buildings in horticulturally enriched areas, such as landscaped recreational resorts, were categorized as "very likely" to cause bird mortality, to the tune of 28 birds per year per structure. The vegetation attracts birds searching for food, which increases the probability of window strikes at the site.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Woodlots need to be >10 ha in size (in Ecoregion 6E) or >5 ha in size (in Ecoregion 7E), and within 5 km of Lake Ontario or Erie to be SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Basic principles for retaining the functions of migratory stopovers are:

1. Minimize the loss and disruption of forest cover (i.e., cluster development where possible);

2. Ensure that development does not completely sever access routes; and

3. Ensure that each area retains a good variety of habitat types.

Large natural areas with plenty of structure are very important to migrating birds. Therefore, development needs to be planned so that as much forest and undisturbed open habitat is maintained as possible.

Golf course fairways, greens, and tees should be aligned so they avoid areas that are used by high concentrations of migrants. Design should be such that the area supports at least the same diversity of habitats after construction as it did originally. Areas of golf courses that will not be used for active play should be managed for migrating landbirds.

For marinas, the footprint of the area that will be disturbed should be minimized. Areas that are not required for the site need to be planted to tree and shrub species that will be attractive to migrating landbirds.

Post-construction mitigation can include restoring the "naturalness" of vegetation by establishing areas of herbaceous plants, shrubs, and trees. Planting berry-producing trees and shrubs may be useful for sites that attract autumn migrants, and patches of native wildflowers will also be attractive to sparrows and finches. Tree and shrub cover is important in areas where spring migrants rest after crossing the lakes. Migrating birds tend not to be as affected by human disturbance as they are attracted to an area by food and cover. It may not be possible to mitigate impacts where clearing in migratory stopover habitat has been extensive.

External lights should be hooded so that they do not shine upwards where they could attract birds in flight. Use of floodlights should be restricted in areas that are important bird stopover areas. Floodlights should not be situated so that they shine into the air or on the face of the building. Low-level and relatively low-power floodlights that are required to illuminate signs may be acceptable it they do not shine up into the air.

To reduce the incidence of daytime bird strikes at golf course clubhouses and marina offices, thought should be given to installing low-reflective glass in windows. These more opaque and typically coloured glasses are visible to birds thereby greatly reducing the potential for bird strikes. However, use of drapes and other materials that cover some or part of the window is very effective in reducing bird strikes. Adding silhouettes of falcons in windows is partially effective but Klem (1990) found that complete or partial covering of windows will eliminate day-time bird strikes. Covering the exterior of windows with netting also prevents birds from striking windows (Klem 1991).

Shrubs that may attract birds should be located either within 1 m or farther than 10 m from a window. This will reduce the incidence of bird mortality due to strikes (Evans Ogden 1996).

Evans Ogden (1996) stated that it is simple to prevent bird collisions with buildings: by night, turn out the lights; by day, make windows visible to birds. These principles should be taken into account when planning new buildings in or adjacent to habitat for migrating birds.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

There is the potential that sand and gravel pits could be located where they affect landbird migratory stopover areas. Removal of vegetation to extract aggregates could affect usage of the area by migratory landbirds.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Woodlots need to be >10 ha in size (in Ecoregion 6E) or >5 ha in size (in Ecoregion 7E), and within 5 km of Lake Ontario or Erie to be SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Basic principles for retaining the functions of migratory stopovers are:

1. Minimize the loss and disruption of forest cover (i.e., cluster development where possible);
2. Ensure that development does not completely sever access routes; and
3. Ensure that each area retains a good variety of habitat types.

Large natural areas with plenty of structure are very important to migrating birds. Where possible, sand and gravel pits should be located where they minimize effects on habitat for migratory landbirds. This will entail avoiding forested areas and minimizing removal of shrub communities.

Provided that sand or gravel extraction does not take place below the water table, loss or degradation of habitat for migratory landbirds may be temporary. Rehabilitation of the pit should be to habitats that will be attractive to migrants. The rehabilitation plan needs to include a mix of tree and shrub species that will provide cover and food for songbirds. As shrubby areas are often more important to migrant landbirds than forested areas, the amount of topsoil provided in the floor of the pit could be varied to provide areas that are likely to remain in shrubs without succession to forest. Additionally, it may be advantageous to have some of the site rehabilitated to forest, depending on the local distribution of habitats. The pit rehabilitation should be planned to complement and improve the diversity of habitat for migrants within the general area.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Wind energy projects have the potential to adversely affect birds through habitat loss, disturbance, and direct fatalities (Kingsley and Whittam 2005; Environment Canada 2007a). With a few important exceptions (e.g., raptors in California), avian fatalities at wind power facilities tend to be low relative to other anthropogenic mortality factors (Kingsley and Whittam 2005). Collisions occur mainly at sites where there are unusual concentrations of birds (e.g., migration corridors) and wind turbines, or where the behaviour of birds puts them at risk (e.g., aerial courtship displaying) (Arcus Renewable Energy Consulting Ltd. 2007).

Greater adverse effects from wind power facility development result from disturbance and habitat loss (Kingsley and Whittam 2005).

Shorelines are often attractive as wind farm localities due to the frequency and velocity of winds. These areas also tend to concentrate migrating and staging birds. While the impact of individual projects is typically quite low, the growth of the industry creates the potential for high levels of impact over time. The Canadian Wildlife Service's guidance on wind turbines and birds (Environment Canada 2007a) suggests that if the proposed site is a known migration corridor, or a significant area of bird concentration, the site should be ranked as having very high potential sensitivity.

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Clearing for any development that encroaches upon staging areas would represent a direct loss of habitat. If the total amount of natural area (forest, old fields, and wetlands) is reduced below a minimum amount, the areas may no longer be suitable for migrating birds; alternatively, the birds may be forced into smaller areas making them more vulnerable to predation and other mortality. Food resources may also become depleted if large numbers of birds are concentrated in small areas.

Negative impacts on birds entering or using a stopover will, in turn, have a negative impact on the habitat itself by reducing its ecological function as a migratory stopover. Among the landbirds, passerines (songbirds) comprise the group most commonly affected by wind energy facilities in North America (Kingsley and Whittam 2005). Protected songbirds comprise 78% of all fatalities documented at wind energy sites in the United States (Erickson et al. 2001, in Kingsley and Wittam 2005). This proportion would be even higher if it included legislatively unprotected species such as the non-native European Starling (Sturnus vulgaris) and House Sparrow (Passer domesticus).

Mitigation Options: Wind Power Facilities

Woodlots need to be >10 ha in size (in Ecoregion 6E) or >5 ha in size (in Ecoregion 7E), and within 5 km of Lake Ontario or Erie to be SWH.

The siting of wind turbines within 120 m of the edge of significant landbird migratory stopover SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on landbird stopover habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Planned wind developments should always be sited to avoid areas that attract large numbers of migrating and staging landbirds. If a wind power facility is planned in an area known to support migratory landbirds, the amount of staging habitat that will be affected by permanent access roads and land clearing for turbines and related infrastructure should be minimized. Areas that are distant from the turbines should be planted to shrubs and trees that will be attractive to migrating landbirds.

There is some potential that migrating birds will avoid wind power facilities so that the presence of a wind farm sterilizes the area for migratory landbirds even if the habitat remains suitable. This potential needs to be discussed with the Canadian Wildlife Service in the planning process.

To avoid disturbance effects, construction and regular maintenance activities should be scheduled to occur when the SWH is not being used by staging landbirds. If post-construction monitoring indicates that a wind power facility is resulting in avoidance behaviour, consideration should be given to shutting down the responsible turbines during the staging period.

Mortality of landbirds due to being struck by turbine blades is relatively low in Ontario (Kingsley and Whittam 2005). Mortality rates may be further decreased by minimizing lighting on the turbines and having intermittent strobe lights as opposed to lights that are continuously on. Lowering the height of the turbine tower will also reduce mortality rates (Barclay et al. 2007).

Potential Development Effects: Solar Power Facilities

Different species of birds forage at different heights within a forest. Some hunt for food on the ground, others forage in the shrub layer while others glean insects from high in the canopy. Vegetation clearing will have an adverse impact on the habitat and its ecological function. As vertical structure is lost, fewer species of forest birds are able to forage efficiently in the remaining habitat (Barrow et al. 2000). Since large numbers of different species of birds concentrate in migratory stopover areas, it is important that the structural complexity of forests be maintained.

If the total amount of natural area (forest, old fields, and wetlands) is reduced below a minimum amount, the areas may no longer be suitable for migrating birds; alternatively, the birds may be forced into smaller areas making them more vulnerable to predation and other mortality. Food resources may also become depleted if large numbers of birds are concentrated in small areas.

Mitigation Options: Solar Power Facilities

Woodlots need to be >10 ha in size (in Ecoregion 6E) or >5 ha in size (in Ecoregion 7E), and within 5 km of Lake Ontario or Erie to be SWH.

The siting of solar panel arrays within 120 m of the edge of significant landbird migratory stopover SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing in landbird stopover habitat will damage or destroy the affected habitat. Large natural areas with plenty of structure are very important to migrating birds. Therefore, development needs to be planned so that as much forest and undisturbed open habitat is maintained as possible. It may not be possible to mitigate impacts where clearing in migratory stopover habitat has been extensive. The best mitigation option is to avoid developing in the habitat.

Where complete avoidance is not possible, and the SWH is large, minimizing the amount of affected habitat may be a satisfactory mitigation option. Start by making the footprint of the development where it affects the habitat as small as possible, and site it at an edge where bird use is low.

Some basic principles for retaining the functions of migratory stopovers include:

1. Minimize the loss and disruption of forest cover (i.e., cluster development where possible);
2. Ensure that development does not completely sever access routes; and
3. Ensure that each area retains a good variety of habitat types.

Post-construction mitigation can include restoring the "naturalness" of vegetation by establishing areas of herbaceous plants, shrubs, and trees. Planting berry-producing trees and shrubs may be useful for sites that attract autumn migrants, and patches of native wildflowers will also be attractive to sparrows and finches. Tree and shrub cover is important in areas where spring migrants rest after crossing the lakes. Migrating birds tend not to be as affected by human disturbance as they are attracted to an area by food and cover.

Schedule construction and regular maintenance activities to occur when birds are not using the habitat.

ROAD DEVELOPMENT

Potential Development Effects

No potential impacts have been identified for this development category.

Mitigation Options

No potential impacts have been identified for this development category.

INDEX #10: RAPTOR WINTERING AREA

Ecoregions:	5E, 6E, 7E
Species Group:	Raptors: Rough-legged Hawk, Red-tailed Hawk, Northern Harrier, American Kestrel, Snowy Owl, Short-eared Owl (SPECIAL CONCERN), Long-eared Owl, Boreal Owl
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Raptor Wintering Area
Habitat Features:	Combination of fields and woodlands (>20 ha)

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Winter habitat for raptors must provide a combination of fields and woodlands that contain roosting, foraging and resting habitats.

Hay fields, pastures and open meadows provide critical winter roosting areas for Northern Harriers and Short-eared Owls in southern Ontario. Sites with key habitat components may attract large numbers of roosting birds, and the two species may occasionally roost together. Sites may be traditional, being used by birds year after year.

Northern Harriers and Short-eared Owls roost on the ground in winter. Good roosting habitat consists of large enough fields (usually >20 ha) so that they are not disturbed, adequate cover and appropriately-coloured vegetation to camouflage the birds, and a nearby source of prey, which is typically meadow voles. Ideal harrier roosts are large stubble fields overgrown with weeds. Initially, roosts may be small and situated in low-lying areas near the hunting grounds. As snow depth increases, birds tend to concentrate in higher areas with less snow cover (Bildstein 1979; MacWhirter and Bildstein 1996; Weller et al. 1955).

Short-eared Owls usually roost in fields in winter, but they have also been documented roosting in marshes, quarries, and gravel pits. As many as 200 birds have been counted in some roosts in the States, with as many as 50 documented in some southern Ontario roosts. Light-coloured vegetation that matches its plumage is preferred, such as timothy, foxtails, and brome grasses. Vegetation density does not appear to be important. Other important components of winter roosts are shelter from the weather, close proximity to a suitable hunting area, and lack of human disturbance. Once snow depths increase to 5 to 10 cm, or if the ground becomes very wet, Short-eared Owls start to roost in coniferous trees (Hendrickson and Swan 1938; Banfield 1947; Kirkpatrick and Conway 1947; Weller et al. 1955; Craighead and Craighead 1956; Fox 1960; Short and Drew 1962; Clark 1975; Colvin and Spaulding 1983; Bosakowski 1986; Johnsgard 1988; Campbell et al. 1990; Holt and Leasure 1993).

Open winter habitats are also preferred by Rough-legged Hawks, Red-tailed Hawks and Snowy Owls. The Rough-legged Hawk winters mostly in open, treeless areas. The species prefers grazed and short-grass habitats, pastures, wet meadows, ploughed fields and roads; it avoids old corn fields, forests, and lake habitats. Although rough-legs usually perch solitarily on utility poles, trees and hills, the species has been reported roosting communally (Bechard and Swem 2002). The Red-tailed Hawk uses open areas with scattered, elevated perch sites in a wide range of altitudes and habitats, including grasslands, agricultural fields, pastures, urban parkland, and broken coniferous and deciduous woodland (Preston and Beane 1993).

Where the Snowy Owl occurs in winter in Ontario, it prefers open places such as fields, prairies, marshes, coasts, and the shorelines of lakes and large rivers. This bird will perch on the ground, fence posts, straw stacks, trees, radio towers and buildings (Godfrey 1986).

Wintering American Kestrels use a wide variety of open to semi-open habitats, including meadows, grasslands, early successional communities in old fields, open parkland, agricultural fields, and both urban and suburban areas. For this species, the vegetation structure of the winter habitat is generally similar to that of the summer habitat, except that winter habitat often has smaller open patches (Smallwood and Bird 2002).

Other wintering raptors in Ontario, such as the Long-eared Owl, occur in more closed habitats, with denser vegetation and smaller open patches. Long-eared Owls inhabit dense vegetation adjacent to grasslands or shrublands used for foraging. Important attributes of winter roosts seem to be dense vegetation for concealment and perhaps thermal cover (Marks et al. 1994).

Potential Development Effects and Mitigation Options

Modification to vegetation structure or drainage patterns in fields or forests supporting a winter roost may make it unattractive. The same is true of areas used for hunting; these are often not the same as those used for roosting. Changes to vegetation and particularly alterations which reduce prey populations may also result in abandonment of the roost. This has the potential to affect a large number of birds. Because roosts tend to be used year after year, loss of one site has the potential to affect wintering populations over a large geographic area.

Communally roosting raptors are highly susceptible to disturbance. Flushing of birds from roosts uses up valuable energy and can affect winter survival potential if disturbance is frequent. Regular disturbance is likely to result in abandonment of the site.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

As raptors generally require relatively large patches for hunting, residential or commercial developments that bisect or fragment such habitat may prove detrimental. Such development is especially problematic when cover and perches are removed.

Increased human activity may disturb raptors to the point where they leave traditional winter roosts. Although some raptors (e.g., Red-tailed Hawks) may be tolerant of human activities, construction degrades the quality of winter habitat by reducing or degrading habitat for some prey species. The development and use of snow machine trails, for example, compresses the runs of small mammals below the snow. This impact reduces the functionality of the habitat for voles, field mice and other small mammals upon which wintering raptors depend for food.

In residential developments, an increase in the number of cats may result in competition for prey. Studies have indicated that cats often reduce vole populations to levels where they are insufficient to support wintering raptors (George 1974).

Mitigation Options

Raptor wintering sites need to be >20 ha in size, with a combination of forest and upland to be SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Impact Assessments for raptor habitat must cover the winter period. Often Impact Assessments focus on the breeding season and ignore the winter.

It may not be possible to effectively mitigate impacts of multi-lot residential or commercial development on field/meadow habitat functioning as a winter habitat for raptors. CompAlete avoidance of winter habitat by development is the optimum mitigation.

It may be very difficult to mitigate the effects of human disturbance as a result of large subdivisions and commercial developments. Chain-link fencing may help to reduce the frequency of disturbance, but this may not always be effective. Disturbance due to pets and competition for food by cats will also be difficult to control.

Drainage patterns in the area to be developed should not be changed and the vegetative structure should be kept the same. Special attention is needed to maintain perch trees and snags, and vegetative cover.

If development is proposed adjacent to fields used for hunting by wintering raptors, the area should be kept as attractive to small mammal populations as possible. This requires a diverse plant community and a structurally complex ground layer. In some instances the loss of field area can be compensated by improvements to the remaining plant community to increase its diversity. Hiding cover and linkages between different areas of the field and nearby fields can be constructed to enhance the habitat for small mammal populations.

Attempts should be made to prevent fields from being greatly reduced in size. This may involve the clustering of development at margins of open areas. If field size is reduced, raptors may abandon roosts or foraging areas. Fields smaller than 15 ha may not have enough small mammals to support wintering raptors and fields smaller than 20 ha are rarely used as winter roosts by harriers or Short-eared Owls (Weller et al. 1955).

The development and use of snow machine trails should be avoided in open fields and other areas known to be used by wintering raptors.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses are the type of major recreational development that is most likely to affect habitat for wintering raptors.

Golf courses are likely to have impacts on wintering raptors only if they are constructed directly in habitat used by hawks and owls for foraging. Human activity on golf courses is minimal in winter and unlikely to have significant impact on wintering raptors.

Construction of a golf course directly in raptor wintering habitat will result in the destruction of that habitat and loss of the local population of wintering raptors.

As raptors generally require relatively large patches for hunting, golf course developments that bisect or fragment such habitat may prove detrimental. Such development is especially problematic when cover and perches are removed.

Mitigation Options

Raptor wintering sites need to be >20 ha in size, with a combination of forest and upland to be SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Impact Assessments for raptor habitat must cover the winter period. Often Impact Assessments focus on the breeding season and ignore the winter.

Conversion of meadow or other habitats to short-mown grass will eliminate cover for raptor prey. Golf course facilities and fairways, greens, and tees should be built outside significant raptor wintering habitat. Fields, coniferous hedgerows, and other treed areas that are used for roosting need to be maintained. Large expanses of naturalized rough could also be incorporated into the course design to encourage small mammal habitation.

Drainage patterns in the area to be developed should not be changed and the vegetative structure should be kept the same. Special attention is needed to maintain perch trees and snags, and vegetative cover.

If development is proposed adjacent to fields used for hunting by wintering raptors, the area should be kept as attractive to small mammal populations as possible. This requires a diverse plant community and a structurally complex ground layer. In some instances the loss of field area can be compensated by improvements to the remaining plant community to increase its diversity. Hiding cover and linkages between different areas of the field and nearby fields can be constructed to enhance the habitat for small mammal populations.

Attempts should be made to prevent fields from being greatly reduced in size. This may involve the clustering of development at margins of open areas. If field size is reduced, raptors may abandon roosts or foraging areas. Fields smaller than 15 ha may not have enough small mammals to support wintering raptors and fields smaller than 20 ha are rarely used as winter roosts by harriers or Short-eared Owls (Weller et al. 1955).

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Sand and gravel pits and quarries may be established in open habitats that support wintering raptors.

In the case of quarries, extraction will probably result in permanent loss of habitat for wintering raptors. Pits may be rehabilitated after the sand and gravel resources are extracted to provide winter raptor habitat provided that extraction did not occur below the water table.

Mitigation Options

Raptor wintering sites need to be >20 ha in size, with a combination of forest and upland to be SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Pits and quarries should be established outside of significant wildlife habitat for wintering raptors.

If it is essential to extract aggregates in a raptor wintering area, sand and gravel pits should be rehabilitated so that they will provide good wintering habitat. This will require spreading of topsoil on the banks and floor of the pit and establishing dense grass cover that is suitable habitats for small rodents such as the Meadow Vole.

If the pit or quarry is adjacent to raptor wintering habitat, the berms of the site should be planted with grasses so that they will also support rodent populations and be suitable foraging habitat for raptors. Provision of artificial perches such as poles and posts with crossbars may also enhance habitat for wintering raptors. Artificial T-shaped perches may be heavily used by Long-eared Owls (Marks et al. 1994) and probably other raptor species.

ENERGY DEVELOPMENT

Potential Development Effects: Biofuel Farms

The ploughing and subsequent conversion of natural grasslands, meadows and fallow fields to farmland to grow crops for ethanol production (e.g., biomass feedstock such as corn and soy) will destroy critical habitat for wintering raptors.

Mitigation Options: Biofuel Farms

Raptor wintering sites need to be >20 ha in size, with a combination of forest and upland to be SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development of biofuel farms in significant raptor wintering areas will make the habitat unsuitable for wintering raptors. The only potential mitigation is to leave some of the land fallow (at least 20 ha) so that it remains available for rodent production that may attract wintering raptors.

Potential Development Effects: Wind Power Facilities

Despite the environmental benefits associated with wind energy, considerable controversy has accompanied the development of wind power facilities and their effects on birds. The main adverse effects of wind power facilities on raptors are mortality through collision with turbine blades and other structures, and displacement of foraging birds as a result of disturbance at the project site (Fielding et al. 2006; Madders and Whitfield 2006). Displacement effectively results in the loss of foraging habitat (Fielding et al. 2006).

Few long-term studies have been conducted on the impacts of wind power facilities on birds, and the focus has been on collision rather than disturbance (Kingsley and Whittam 2005). In terms of disturbance effects, early evidence suggests that raptors may experience habitat loss through displacement around wind farms. In a Norwegian study, the number of White-tailed Eagle pairs holding territories within 500 m of a wind farm site fell from 13 pre-construction to only 5 at 4 years post-construction (Nygard et al. 2010), suggesting displacement of the missing pairs. Additionally, at the wind power site in Wisconsin, raptor abundance was reduced 47% post-construction compared to pre-construction levels (Garvin et al. 2010). The authors concluded that this decline may have been a result of displacement due to the disturbance of wind farm construction and the ongoing presence of turbines and maintenance machinery. Another study in Wisconsin (Howe et al. 2002, in Garvin et al. 2010) found that open-country raptors were more abundant in the reference area surrounding the subject wind farm than within the wind farm study area. Displacement has not been studied at the Californian Wind Resource Areas (Whitfield 2009). On the other hand, there was no evidence of Golden Eagle displacement at Foote Creek Rim, Wyoming (Johnson et al. 2000, in Whitfield 2009. Lack of displacement means little indirect habitat loss, but it also means that the birds are at risk by venturing into the environs of operating turbines.

Diurnal raptors (e.g., eagles, buteos, accipiters, Northern Harrier, Osprey, falcons, and Turkey Vultures) appear to be particularly susceptible to being killed by striking turbine blades at wind power facilities. Bird vulnerability and mortality reflects a combination of site-specific (wind-relief interaction), species-specific and seasonal factors (Barrios and Rodríguez 2004). Raptors are more likely to collide with turbine blades than many other avian species due to their morphology and foraging behaviour (e.g., heavy wing loading, focus on distant prey (Janss 2000; Kikuchi 2008)). High mortality rates have been documented in California and at Tarifa and Navarre in Spain (Kingsley and Whittam 2005). At Altamount Pass and Tehachapi Pass in California, most raptor deaths were recorded during the winter when the birds were hunting for mammalian prey (Kingsley and Whittam 2005). Drewitt and Langston (2008) stated that certain birds of prey have good binocular vision but poor peripheral vision, which might explain why they run into transmission wires and turbine blades. Additionally, some raptor species may begin courtship displays in late winter in anticipation of the breeding season. Those that display aerially, such as Northern Harrier and Short-eared Owl, may be particularly vulnerable to being struck by turbine blades. Negative impacts on raptors using a wintering area will, in turn, have a negative impact on the habitat itself by reducing its ecological function as a wintering area.

The most important factor that influences turbine-related mortality for raptors appears to be topography. Landform features such as elevation, ridges and slopes are likely very important in determining the amount of raptor mortality in areas where raptors are abundant (Anderson et al. 2000, in Kingsley and Whittam 2005). Higher elevations and complex terrain (many ridges and slopes) appear to coincide with greater raptor mortality than lower elevations and simpler terrain. In their study of Spain's PESUR wind facility, Barrios and Rodríguez (2004) concluded that a scarcity of thermals in winter made sloping topography, and the updraft air currents often found there, attractive to soaring vultures; this influenced exposure to turbines and turbine-related mortality.

The development of wind power facilities also has the potential to result in direct loss of wintering habitat for raptors. Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Site preparation that includes the clearing of perch trees effectively changes the form of the wintering habitat and reduces its ecological function.

Mitigation Options: Wind Power Facilities

Raptor wintering sites need to be >20 ha in size, with a combination of forest and upland to be SWH.

The siting of wind turbines within 120 m of the edge of significant raptor wintering habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on raptor wintering habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

If the raptor wintering habitat is of sufficient size (e.g., 50 ha), siting the development as far from the edge as possible and where raptor activity is low may be a satisfactory mitigation option. New wind installations must be preceded by detailed behavioural observation of soaring birds as well as careful mapping of migration routes (Barrios and Rodríguez 2004).

Where wind power facilities are developed adjacent to significant raptor wintering habitat, another possible mitigation option might be to make the habitat immediately around each turbine unattractive to raptors and their prey species. If the area is essentially devoid of perches and prey, raptors may be encouraged to hunt elsewhere. For example, installing larger than standard turbine pads and/or keeping the surrounding vegetation very short may be effective strategies. Additionally, there is speculation in the literature that the construction of tubular (as opposed to lattice-type) towers and slower blade speeds may also help to reduce raptor fatalities at wind power facilities. There is some evidence that lattice-type towers encourage raptor perching which puts the birds at risk from collision mortality (Smallwood and Thelander 2004). If lattice-type towers must be used, wrapping the tower with wire mesh may be sufficient to discourage perching by raptors.

Potential Development Effects: Solar Power Facilities

The conversion of natural grasslands, meadows and fallow fields to solar farms will destroy critical habitat for wintering raptors.

Mitigation Options: Solar Power Facilities

Raptor wintering sites need to be >20 ha in size, with a combination of forest and upland to be SWH.

The siting of solar panel arrays within 120 m of the edge of significant raptor wintering habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development of solar power facilities in significant raptor wintering areas will make the habitat unsuitable for wintering raptors. The only potential mitigation is to leave some of the land fallow (at least 20 ha) so that it remains available for rodent production that may attract wintering raptors.

ROAD DEVELOPMENT

Potential Development Effects

New roads that pass through raptor wintering habitat will result in loss of habitat under the footprint of the road.

Mitigation Options

Raptor wintering sites need to be >20 ha in size, with a combination of forest and upland to be SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

If possible, roads should always be directed away from winter raptor habitat. If it is essential to traverse winter raptor habitat, it would be preferable to route the road along the edge of the habitat instead of directly through it.

Installation of hydro/telephone lines and fence posts along the new road may actually increase the availability of perches for wintering raptors.

INDEX #11: BALD EAGLE WINTER HABITAT

Ecoregions:	6E, 7E
Species Group:	Bald Eagle (SPECIAL CONCERN)
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Over-wintering Habitat

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Bald Eagles winter along shorelines of large bodies of water which provide areas of open water where fish are abundant and accessible. Significant habitat includes feeding areas, winter roosting sites, and trees regularly used for perching. Eagles roost in large trees growing in shoreline forest stands or on cliffs. The location of winter roosting sites may change within and among winters depending upon ice conditions and fish distribution, but the same general areas are used traditionally. In many cases, the same trees will be used year after year (Buehler 2000).

The availability of suitable roost sites is an important habitat feature in the recovery of this species. Roosting sites function to provide protective cover within a reasonable distance from important winter feeding areas. They provide shelter from inclement weather and are in areas that are isolated from human disturbance (Buehler 2000).

For an area to function as a winter roost site for Bald Eagles it must be located near areas of open water. Nocturnal roosts reported in eastern North America have mostly been within 1 km of water, but western populations frequently roost more than 10 km from feeding areas, and one roost was 29 km from the feeding site (Buehler 2000). Eagles may also frequent deer yards where they may feed on carcasses (Lang et al. 1999). Highest concentrations of eagles will be found near areas offering the best fishing. An abundant supply of undisturbed mature trees or snags distributed evenly along shorelines is important to ensure that eagles can alter their winter distribution patterns depending upon ice conditions and fish distribution. Nocturnal roosts may be communal; site characteristics that facilitate social interaction in communal roosts, such as information exchange, also may affect roost-site selection (Buehler 2000). Virtually all roost sites are protected from the prevailing wind. In eastern North America, both deciduous and coniferous trees are used for roosting, while only conifers are used in the west. Energetics may define where nocturnal roosts are located. Birds may fly past dense deciduous woods to roost in coniferous trees, or may roost in less favourable habitat if the more suitable habitat is distant from the feeding area (Buehler 2000). One common characteristic of nocturnal roosts is that they are distant from roads and human activity (Buehler 2000).

Most individual trees that are used for perching are “super canopy” trees near good foraging habitat; they tend to be open for easy access and have a clear view of the water. Roosts may double as hunting perches. Bald Eagles also use snags, or tall dead, partially dead or living trees for perching.

Good foraging habitat is characterized by conditions that make live fish available to the limited fishing ability of Bald Eagles, or conditions that make fish, birds, and mammals available as carrion (Buehler 2000). Bald Eagles typically forage at or near the water's surface, usually close (<500 m) to shoreline perching habitat.

Potential Development Effects and Mitigation Options

In their study of roosting sites around Chesapeake Bay, Buehler et al. (1991a,b) noted that 86% of roosting sites were found in woodlots greater than 40 ha, and none were in human developed habitat. Human disturbance at roosts sites should thus be minimized; Grier et al. (1983) and Lanier and Foss (1989, in Naylor and Watt 2004) recommended no human activities within 400 m and 500 m of nocturnal winter roosts, respectively. Other studies recommend even greater development setbacks, as described below.

Shoreline development which results in the loss of significant numbers of mature trees or snags will affect the function of the area as winter roosting and perching habitat for Bald Eagles. Even the loss of one or two key trees or snags could make the habitat unsuitable.

Any development on adjacent lands which increases human activity may result in abandonment of the area. Eagles tolerate moving vehicles, but tend to flush when a vehicle stops (Martell 1992). They are very intolerant of pedestrians and may flush from perches at distances as great as 300 m. Birds that are frequently disturbed will leave an area (Brownell and Oldham 1984; Fraser 1985; Sabine and Klimstra 1985; Marr et al. 1995; Stalmaster and Kaiser 1998). Nocturnal roosts are more sensitive than feeding perches, as they may support the entire wintering population of an area.

Grier et al. (2002) concluded that human disturbance of the Bald Eagle was a complex issue that was important to consider, but not an absolute problem or necessarily serious to the population status or welfare of the species in Ontario. They cautioned that specific qualitative data were required on the subject of setbacks, due to varying degrees of habituation under different circumstances.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Residential development, whether low-density rural development or cottage development, may overlap with areas of Bald Eagle over-wintering habitat, particularly when such development occurs along or near the shorelines of large bodies of open water or in the vicinity of cliffs used for roosting. Such residential development (and associated road development) can not only result in the physical loss of habitat, but may also increase human use (e.g., recreational use, vehicular traffic) of an area to a level that is intolerable to bald eagles.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development should always avoid known Bald Eagle winter roosting and perching sites.

The following paragraphs provide information on buffers and setbacks from Bald Eagle winter roosts and hunting perches. It will be noted that there is a wide disparity in the recommended distances that activities may occur within these habitats. This is because the response of eagles is highly variable to different types of disturbance and is also dependent upon the individual eagle's experience with humans. In addition, many of the older references were very conservative and recommended very large buffers. It is now realized that eagles are more tolerant of human alterations of the landscape and disturbance than was previously thought (OMNR

2008a). In addition, winter nocturnal roosts are more sensitive than perches. Roosts may support an entire local population and loss or regular disturbance of this habitat may result in eagles abandoning an area. Feeding perches are important, but less critical to eagles. If an eagle is disturbed from a perch, it may simply fly to another. However, removal of perches may reduce hunting success or even lower the carrying capacity of the area for eagles.

A buffer of 300 m is recommended from Bald Eagle winter perches. This is the distance that was recommended by Timmerman and Halyk (2001) for eagles wintering in the City of Cambridge. This distance was based on a detailed review of the literature. These eagles appeared to be habituated to human disturbance and approached buildings, roads, and pedestrians at much closer distances than 300 m. However, 300 m is recommended as this distance should be sufficient to protect perching eagles even in areas where they are not accustomed to human activity (Stalmaster and Kaiser 1998).

Limited information is available on appropriate buffers from nocturnal roosts. Martell (1992) recommended that roads not pass within 800 m of a roost and that fencing should be used to keep pedestrians from approaching within 400 m. These appear to be conservative estimates. It is recommended that pedestrians not be allowed within 400 m of a nocturnal roost and that development not be allowed within 500 m, following the recommendation of Lanier and Foss (1989, in Naylor and Watt 2004).

When considering mitigation, it is important to think about when these habitats are being used. Winter habitat is generally occupied by Bald Eagles from about mid-November to late February. Activities that occur outside of this timeframe are unlikely to affect eagles provided that the habitat is left intact. In addition, the roosts are only used at night. This eliminates some of the human disturbance factors as there are likely to be fewer pedestrians, etc. when the roost is occupied.

Winter roosting and perching areas can be maintained or enhanced by maintaining large trees and snags where possible, planting trees close to feeding sites, and curtailing human activity (especially during the winter period when eagles are present).

Washington State (Stinson et al. 2001) requires that Bald Eagle management plans be created for residential developments, non-residential development, road construction, and shoreline development proposed for lands on which there are Bald Eagle roosting (or nesting) sites. For multi-residential developments, these plans include specific roost management plans. In response to escalating shoreline development within the Puget Sound region, abbreviated, template Bald Eagle plans have been developed, tailored for single family- and small multi-residential development. These plans specify habitat protections and/or timing restrictions for properties falling within 243 m of a Bald Eagle nest or roost, or between 243 and 800 m, but within 76 m of the shore or high bank bordering a shoreline where important eagle foraging perches are typically found. These abbreviated Bald Eagle plans are issued at county permitting agencies when landowners seek grading, septic, and/or building permits. A key component of the management plan process is determining habitat protection and/or timing conditions based on landowner objectives and site specific factors. Roost site eagle management plans apply combinations of no cut buffers, partial retention of trees, and large tree retention as conditions.

The United States Fish and Wildlife Service (USFWS 2007) recommended that explosives not be used within 800 m of roosting sites, or within 1,600 m of roosting areas in open areas. They also recommended that aircraft corridors be located no closer than 300 m vertical or horizontal distance from communal roost sites.

Artificial perches have been constructed and used successfully in some locations. For example, the Chelan Public Utility District in Washington erected 4 artificial perches along a treeless area upstream from Rocky Reach Dam on the Columbia River. These perches are frequently used by wintering eagles. Artificial perches were also erected by the Bureau of Reclamation near Grand Coulee Dam so that eagles would have a place to perch while viewing the tailrace area for dead and injured fish (Stinson et al. 2001).

Increased human population in an area as a result of development may increase recreational pressure, such as fishing and walking along rivers and lakes. It may be necessary to restrict pedestrian and snowmobile access from key Bald Eagle wintering habitat.

Required setbacks may vary site-to-site depending upon the level of habituation that eagles demonstrate to human activity. In addition, required setbacks may vary depending upon the visibility of perches and roosts. If the proposed development is screened from critical habitat by forest cover or changes in topography, eagles may be less sensitive to human disturbance. In southern Ontario, wintering Bald Eagles occur regularly in the city of Cambridge and in Paris with perches within a few metres of an active trail system and Highway 401. Consequently, it is important to establish site-specific guidelines for setbacks and this should be done with the assistance of the Ontario Ministry of Natural Resources. If no site-specific guidelines are developed to take into account local reaction of eagles to human activity, the buffers should be 500 m for subdivisions, roads, and commercial development and 400 m for pedestrians for nocturnal roosts; and 300 m for diurnal perches.

To minimize disturbance, construction that is near Bald Eagle wintering habitat should be conducted outside of the wintering season, provided that it does not interfere with nesting activities.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Recreational developments may overlap with areas of Bald Eagle over-wintering habitat, particularly when such development occurs along or near the shorelines of large bodies of open water or in the vicinity of cliffs used for roosting. Such residential development (and associated road development) can not only result in the physical loss of habitat, but may also increase human use (e.g., recreational use, vehicular traffic) of an area to a level that is intolerable to bald eagles.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Golf courses are not likely to be a major concern as they will support minimal human activity in winter. However, golf courses should always be designed so that they do not directly affect any roosting or perching habitat.

Other types of recreational developments, such as ski resorts where there is high human activity in winter, should always avoid known Bald Eagle winter roosting and perching sites.

The following paragraphs provide information on buffers and setbacks from Bald Eagle winter roosts and hunting perches. It will be noted that there is a wide disparity in the recommended distances that activities may occur within these habitats. This is because the response of eagles is highly variable to different types of disturbance and is also dependent upon the individual eagle's experience with humans. In addition, many of the older references were very conservative and recommended very large buffers. It is now realized that eagles are more tolerant of human alterations of the landscape and disturbance than was previously thought (OMNR 2008a). In addition, winter nocturnal roosts are more sensitive than perches. Roosts may support an entire local population and loss or regular disturbance of this habitat may result in eagles abandoning an area. Feeding perches are important, but less critical to eagles. If an eagle is disturbed from a perch, it may simply fly to another. However, removal of perches may reduce hunting success or even lower the carrying capacity of the area for eagles.

A buffer of 300 m is recommended from Bald Eagle winter perches. This is the distance that was recommended by Timmerman and Halyk (2001) for eagles wintering in the City of Cambridge. This distance was based on a detailed review of the literature. These eagles appeared to be habituated to human disturbance and approached buildings, roads, and pedestrians at much closer distances than 300 m. However, 300 m is recommended as this distance should be sufficient to protect perching eagles even in areas where they are not accustomed to human activity (Stalmaster and Kaiser 1998).

Limited information is available on appropriate buffers from nocturnal roosts. Martell (1992) recommended that roads not pass within 800 m of a roost and that fencing or means should be used to keep pedestrians from approaching within 400 m. These appear to be conservative estimates. It is recommended that pedestrians not be allowed within 400 m of a nocturnal roost and that development not be allowed within 500 m, following the recommendation of Lanier and Foss (1989, in Naylor and Watt 2004).

When considering mitigation, it is important to think about when these habitats are being used. Winter habitat is generally occupied by Bald Eagles from about mid-November to late February. Activities that occur outside of this timeframe are unlikely to affect eagles provided that the habitat is left intact. In addition, the roosts are only used at night. This eliminates some of the human disturbance factors as there are likely to be fewer pedestrians, etc. when the roost is occupied.

Winter roosting and perching areas can be maintained or enhanced by maintaining large trees and snags where possible, planting trees close to feeding sites, and curtailing human activity (especially during the winter period when eagles are present).

Washington State (Stinson et al. 2001) requires that bald eagle management plans be created for residential developments, non-residential development, road construction, and shoreline development proposed for lands on which there are bald eagle roosting (or nesting) sites. For multi-residential developments, these plans include specific roost management plans. In response to escalating shoreline development within the Puget Sound region, abbreviated, template bald eagle plans have been developed, tailored for single family- and small multi-residential development. These plans specify habitat protections and/or timing restrictions for properties falling within 800 feet of a bald eagle nest or roost, or between 800 and 2,640 ft, but within 250 ft of the shore or high bank bordering a shoreline where important eagle foraging perches are typically found. These abbreviated bald eagle plans are issued at county permitting agencies when landowners seek grading, septic, and/or building permits. A key component of the management plan process is determining habitat protection and/or timing conditions based on landowner objectives and site specific factors. Roost site eagle management plans apply combinations of no cut buffers, partial retention of trees, and large tree retention as conditions.

The United States Fish and Wildlife Service (2007) recommended that explosives not be used within 800 m of roosting sites, or within 1,600 m of roosting areas in open areas. They also recommended that aircraft corridors be located no closer than 300 m vertical or horizontal distance from communal roost sites.

Artificial perches have been constructed and used successfully in some locations. For example, the Chelan Public Utility District in Washington erected 4 artificial perches along a treeless area upstream from Rocky Reach Dam on the Columbia River. These perches are frequently used by wintering eagles. Artificial perches were also erected by the Bureau of Reclamation near Grand Coulee Dam so that eagles would have a place to perch while viewing the tailrace area for dead and injured fish (Stinson et al. 2001).

Increased human population in an area as a result of development may increase recreational pressure, such as fishing and walking along rivers and lakes. It may be necessary to restrict pedestrian and snowmobile access from key Bald Eagle wintering habitat.

Required setbacks may vary site-to-site depending upon the level of habituation that eagles demonstrate to human activity. In addition, required setbacks may vary depending upon the visibility of perches and roosts. If the proposed development is screened from critical habitat by forest cover or changes in topography, they may be less sensitive to human disturbance. In southern Ontario, wintering Bald Eagles occur regularly in the city of Cambridge and in Paris with perches within a few metres of an active trail system and Highway 401. Consequently, it is important to establish site-specific guidelines for setbacks and this should be done with the assistance of the Ontario Ministry of Natural Resources. If no site-specific guidelines are developed to take into account local reaction of eagles to human activity, the buffers should be 500 m for subdivisions, roads, and commercial development and 400 m for pedestrians for nocturnal roosts; and 300 m for diurnal perches.

To minimize disturbance, construction that is near Bald Eagle wintering habitat should be conducted outside of the wintering season, provided that it does not interfere with nesting activities.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Development in this category is unlikely to have any direct impacts on Bald Eagle wintering habitat. However, noise from pits and quarries has the potential to disturb wintering Bald Eagles.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Unless habituation to pit and quarry activity is demonstrated by wintering Bald Eagles, extraction activities should never occur within 300 m of known perches and blasting should never occur within 800 m of a nocturnal roost. If negative responses are exhibited by eagles to extraction activities, it may be necessary to shut down operations during the eagle's wintering period (mid-November until the end of February).

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Despite the environmental benefits associated with wind energy, considerable controversy has accompanied the development of wind power facilities and their effects on birds. The main adverse effects of wind power facilities on raptors are mortality through collision with turbine blades and other structures, and displacement of foraging birds as a result of disturbance at the project site (Fielding et al. 2006; Madders and Whitfield 2006). Displacement effectively results in the loss of foraging habitat (Fielding et al. 2006).

Few long-term studies have been conducted on the impacts of wind power facilities on birds, and the focus has been on collision rather than disturbance (Kingsley and Whittam 2005). In terms of disturbance effects, early evidence suggests that raptors may experience habitat loss through displacement around wind farms. In a Norwegian study, the number of White-tailed Eagle pairs holding territories within 500 m of a wind farm site fell from 13 pre-construction to only 5 at 4 years post-construction (Nygard et al. 2010), suggesting displacement of the missing pairs. Additionally, at the wind power site in Wisconsin, raptor abundance was reduced 47% post-construction compared to pre-construction levels (Garvin et al. 2010). The authors concluded that this decline may have been a result of displacement due to the disturbance of wind farm construction and the ongoing presence of turbines and maintenance machinery. Another study in Wisconsin (Howe et al. 2002, in Garvin et al. 2010) found that open-country raptors were more abundant in the reference area surrounding the subject wind farm than within the wind farm study area. Displacement has not been studied at the Californian Wind Resource Areas (Whitfield 2009). On the other hand, there was no evidence of Golden Eagle displacement at Foote Creek Rim, Wyoming (Johnson et al. 2000, in Whitfield 2009. Lack of displacement means little indirect habitat loss, but it also means that the birds are at risk by venturing into the environs of operating turbines.

Bald Eagles can be affected by wind power facilities in two ways: directly and indirectly. Direct effects include being injured or killed by collision with the turbine blades, the turbine towers, transmission wires, and other associated structures. Drewitt and Langston (2008) stated that certain birds of prey have good binocular vision but poor peripheral vision, which might explain why they run into transmission wires and turbine blades. Direct effects also include electrocution by wind power facility transmission lines. Indirect effects include displacement from an area due to habitat loss, increased energy use to avoid wind power structures, and avoidance of an area due to noise, structures and human activity. Roosting eagles are sensitive to disturbance (Grier et al. 1983; Buehler et al. 1991a,b; Lanier and Foss 1989, in Naylor and Watt 2004). Turbines that are visible from roost trees may discourage continued use of those roosting sites.

Diurnal raptors (including eagles) appear to be particularly susceptible to being killed by striking turbine blades at wind power facilities. Bird vulnerability and mortality reflects a combination of site-specific (wind-relief interaction), species-specific and seasonal factors (Barrios and Rodríguez 2004). Raptors are more likely to collide with turbine blades than many other avian species due to their morphology and foraging behaviour (e.g., heavy wing loading, focus on distant prey (Janss 2000; Kikuchi 2008)). High mortality rates have been documented in California and at Tarifa and Navarre in Spain (Kingsley and Whittam 2005). At Altamount Pass and Tehachapi Pass in California, most raptor deaths were recorded during the winter when the birds were hunting for mammalian prey (Kingsley and Whittam 2005). Drewitt and Langston (2008) stated that certain birds of prey have good binocular vision but poor peripheral vision, which might explain why they run into transmission wires and turbine blades. Negative impacts on eagles using a wintering area will, in turn, have a negative impact on the habitat itself by reducing its ecological function as a wintering area.

The most important factor that influences raptor collision appears to be topography. Landform features such as elevation, ridges and slopes are likely very important in determining the amount of raptor mortality in areas where raptors are abundant (Anderson et al. 2000, in Kingsley and Whittam 2005). Higher elevations and complex terrain (many ridges and slopes) appear to coincide with greater raptor mortality than lower elevations and simpler terrain.

The development of wind power facilities also has the potential to result in direct loss of Bald Eagle wintering habitat. Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Site preparation that includes the clearing of roost trees effectively changes the form of the wintering habitat and reduces its ecological function.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the outer edge of any ELC ecosite that contains significant Bald Eagle wintering habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

If the Bald Eagle wintering habitat is of sufficient size, siting the development as far from the edge as possible, and where it will not intercept eagles traveling between the roost and foraging habitat, may be a satisfactory mitigation option. Locate the development in an area of low raptor activity.

Options for mitigating disturbance impacts include retaining a visual barrier of tall trees between the development and the roost trees so that turbines are not visible to the birds. Where possible, consider using turbines that are shorter than the roost trees. Construction-related disturbance impacts can be mitigated by scheduling the work to occur outside of the eagle wintering timeframe of mid-November to late February (Kochert and Olendorff 1999).

Eagle mortality as a result of electrocution can be reduced by incorporating raptor-safe features into the design of any new power distribution system (Olendorff et al. 1996, in Stinson et al. 2001). Safety features include insulation of wires and hardware, adequate spacing of conductors and grounded hardware, and perch deterrents (Kochert and Olendorff 1999).

Potential Development Effects: Solar Power Facilities

Forest clearing for the installation of solar panels, access roads, transmission wire and other project components in Bald Eagle winter habitat will destroy the affected habitat. Indirect effects reduce the ecological function of retained habitat, and include eagle mortality due to electrocution by facility transmission lines, displacement of wintering eagles through avoidance of structures, and disturbance. Development typically brings increased human activity (e.g., construction, regular maintenance activities), which will further reduce the habitat's ecological function as eagles are intolerant of human disturbance.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of the outer edge of any ELC ecosite that contains significant Bald Eagle wintering habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Large-scale vegetation clearing for solar panels, access roads and other project components may damage or destroy bald eagle wintering habitat, particularly if it occurs along or near the shorelines of large bodies of open water or in the vicinity of cliffs used for roosting. The best mitigation option is to avoid developing in the habitat.

Where complete avoidance is not possible, and the Bald Eagle wintering habitat is of sufficient size, siting the development as far from the edge as possible, and where it will not interfere with eagles traveling between the roost and foraging habitat, may be a satisfactory mitigation option. Locate the development in an area of low raptor activity.

Options for mitigating disturbance impacts include retaining a visual barrier of tall trees between the development and the roost trees so that the project and components are not visible to the birds. Construction-related disturbance impacts can be mitigated by scheduling the work to occur outside of the eagle wintering timeframe of mid-November to late February (Kochert and Olendorff 1999), provided that it does not interfere with nesting activities.

Eagle mortality as a result of electrocution can be reduced by incorporating raptor-safe features into the design of any new power distribution system (Olendorff et al. 1996, in Stinson et al. 2001). Safety features include insulation of wires and hardware, adequate spacing of conductors and grounded hardware, and perch deterrents (Kochert and Olendorff 1999).

The following paragraphs provide information on buffers and setbacks from Bald Eagle winter roosts and hunting perches. It will be noted that there is a wide disparity in the recommended distances that activities may occur within these habitats. This is because the response of eagles is highly variable to different types of disturbance and is also dependent upon the individual eagle's experience with humans. Additionally, many of the older references were very conservative and recommended very large buffers. It is now realized that eagles are more tolerant of human alterations of the landscape and disturbance than was previously thought (OMNR 2008a). Winter nocturnal roosts are more sensitive than perches. Roosts may support an entire local population and loss or regular disturbance of this habitat may result in eagles abandoning an area. Feeding perches are important, but less critical to eagles. If an eagle is disturbed from a perch, it may simply fly to another. However, removal of perches may reduce hunting success or even lower the carrying capacity of the area for eagles.

A buffer of 300 m is recommended from Bald Eagle winter perches. This is the distance that was recommended by Timmerman and Halyk (2001) for eagles wintering in the City of Cambridge. This distance was based on a detailed review of the literature. These eagles appeared to be habituated to human disturbance and approached buildings, roads, and pedestrians at much closer distances than 300 m. However, 300 m is recommended as this distance should be sufficient to protect perching eagles even in areas where they are not accustomed to human activity (Stalmaster and Kaiser 1998).

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When considering mitigation, it is important to think about when these habitats are being used. Winter habitat is generally occupied by Bald Eagles from about mid-November to late February. Activities that occur outside of this timeframe are unlikely to affect eagles provided that the habitat is left intact. In addition, the roosts are only used at night. This eliminates some of the human disturbance factors as there are likely to be fewer pedestrians, etc. when the roost is occupied.

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Washington State (Stinson et al. 2001) requires that Bald Eagle management plans be created for residential developments, non-residential development, road construction, and shoreline development proposed for lands on which there are Bald Eagle roosting (or nesting) sites. These plans specify habitat protections and/or timing restrictions for properties falling within 243 m of a Bald Eagle nest or roost, or between 243 and 800 m, but within 76 m of the shore or high bank bordering a shoreline where important eagle foraging perches are typically found. Bald Eagle plans are issued at county permitting agencies when landowners seek grading, septic, and/or building permits. A key component of the management plan process is determining habitat protection and/or timing conditions based on landowner objectives and site specific factors. Roost site eagle management plans apply combinations of no cut buffers, partial retention of trees, and large tree retention as conditions.

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Required setbacks may vary site-to-site depending upon the level of habituation that eagles demonstrate to human activity. Additionally, required setbacks may vary depending upon the visibility of perches and roosts. If the proposed development is screened from critical habitat by forest cover or changes in topography, eagles may be less sensitive to human disturbance. In southern Ontario, wintering Bald Eagles occur regularly in the city of Cambridge and in Paris with perches within a few metres of an active trail system and Highway 401. Consequently, it is important to establish site-specific guidelines for setbacks and this should be done with the assistance of the Ontario Ministry of Natural Resources. If no site-specific guidelines are developed to take into account local reaction of eagles to human activity, the buffers should be: 500 m for commercial development and roads; 400 m for pedestrians for nocturnal roosts; and 300 m for diurnal perches.

ROAD DEVELOPMENT

Potential Development Effects

Roads have the potential to affect Bald Eagle wintering habitat if they are built close to rivers supporting eagles, or if new bridges will be built over the river.

Most effects are related to disturbance, but new roads also have the potential to destroy perches or roosts.

Although eagles are tolerant of moving vehicles, they may be disturbed by vehicles that slow down or stop. They may also be disturbed by pedestrians that may be walking along the roadside or over bridges.

Roads are most likely to have impacts when they are in or near Bald Eagle wintering habitat in an urban area. This is where vehicles are likely to slow due to heavy traffic or pedestrians are likely to be common. These were some of the concerns when a new arterial road system was proposed for the City of Cambridge (Timmerman and Halyk 2001).

Construction activity also has the potential to disturb wintering Bald Eagles.

Mitigation Options

If possible, roads should always be routed so they do not intercept Bald Eagle wintering habitat. When new roads are essential, those that run parallel to the river need to be set back far enough that eagles are unlikely to be disturbed when using perches.

Roads should always be designed so that they avoid key habitats, and routed to avoid close contact with perches and especially roosts.

If possible, bridges should not cross at important foraging areas such as sites where wintering waterfowl concentrate or where there are shallow rapids that support diverse fish communities. Areas near confluences of rivers should be avoided as these are often important foraging areas. Crossing at key foraging areas may result in the eagles avoiding these areas and thus having less food available to them.

Special design considerations may be necessary if pedestrians are going to use bridges that will be within 300 m or so of regularly used perches. Depending upon birds' previous experience with human activities, birds within 300 m may flush when they see a pedestrian. Opaque Plexiglas barriers should be installed on the outer side of sidewalks across bridges at suitable heights so that pedestrians are not visible to eagles on perches.

Construction activity should not occur within winter near key foraging areas, perches, and especially roosts.

INDEX #12: BAT MATERNITY COLONIES

Ecoregions:	All of Ontario
Species Group:	Big Brown Bat, Silver-Haired Bat
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Bat Hibernacula Maternity Colony
Habitat Features:	Maternity colonies: mature to over-mature mixed and deciduous stands with large diameter dead or dying trees with cavities The Little Brown Myotis (ENDANGERED) and Northern Long-Eared Myotis (ENDANGERED) are protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that may affect these species.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Developments
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Maternity Colonies

Not a lot is known about bat maternity colonies, except that they are critical to the survival of local bat populations (Humphrey 1975; Fenton 1997). Sub-optimal roosts may result in reduced reproductive success (Brigham and Fenton 1986).

Bat maternity (or nursery) colonies are day roosts inhabited solely by females and juveniles/subadults (Griffin 1940; Fenton et al. 2005a), and are used for giving birth and raising young (OMNR 2006a). Pregnant and lactating females gather to form maternity colonies that range in size from tens to hundreds of adult females and their young (Griffin 1940; Fenton et al. 2005a). Maternity colonies can be located in human structures (e.g., barns and attics), abandoned mines, tree hollows and rock faces. For many species, mature/intact forest habitat is important, with mature to over-mature trees that include dead or dying stems (snags) (Hutchinson and Lacki 2000; Owen 2003; Psyllakis and Brigham 2005). Some species do not aggregate to form large maternity colonies, but rather roost individually in the foliage of trees. Generally, buildings are not considered SWH.

For those species that form maternity colonies, these aggregations provide a critical function during the birthing and rearing stages of the bats' life histories. For example, maternity colonies are known to reduce the energy expenditure of lactating mothers and pups, thereby increasing survival rates (OMNR 2006a). When there are many individuals in a roost, body heat is concentrated which provides thermoregulatory benefits for pup-rearing females (Yates 2006). Other benefits may include possible information transfer among individuals within the same roost about quality foraging areas (Wilkinson 1992). Additionally, young bats grow best where daytime temperatures are in the 26o-32oC range (Gerson 1984); the warm temperatures within maternity colonies help to accelerate growth of the young, which have only a short time to build up their fat reserves between weaning and hibernation (Fenton 1983, in OMNR 2006a). Juveniles older than 3-4 days remain in the protective sanctuary of the roost at night while the mother goes hunting (Griffon 1940). Lactating female bats rely on current resource intake to meet the energetic demands of reproduction (Henry et al. 2002). Females raising young have reduced foraging ranges and thus forage more intensively near maternity colonies, thus increasing the levels of bat activity near maternity colonies (Henry et al. 2002).

See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

There are several factors responsible for the decline of bat populations; these factors probably vary from species to species and area to area. The most important threats to the survival of bats include destruction of hibernating bats and nursery colonies, habitat loss, and persecution (Gerson 1984).

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Maternity Colonies

Potential Development Effects

Site alterations which result in the loss of vegetation can reduce the ecological function of bat maternity colonies. Deforestation near maternity colony sites and between these sites and feeding areas may result in decreased prey availability (Barclay 1984), decreased foraging efficiency, and increased vulnerability to predators (Tuttle 1979). Since suitable maternity colony sites are limited, the loss of any site has significant impacts on bat populations.

Developments which result in significant forest clearing will impact nursery colonies of those bats which nurse in forested areas (or in the crevices of rocks therein). Old buildings, such as old houses, barns and abandoned structures often serve as maternity roosts, so bats will be negatively affected if they are razed. For example, Big Brown Bats frequently form nursery colonies in buildings; a major cause of population decline in these species is extermination of these nursery colonies. Humphrey (1982) suggested that most bats that are excluded from their nursery roosts disperse, but presumably die since marked animals do not return to their traditional hibernation sites.

Development near bat maternity colonies may increase human disturbance at these sites. Some bat species are known to abandon summer roosts because of human disturbance (Barbour and Davis 1969). Human disturbance near bat maternity colonies has also been known to cause female bats to drop their pups to the ground to flee from intruders, or to abandon their young altogether (Nolan 1997).

Mitigation Options

Development will not be permitted in bat maternity colony SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the habitat includes the entire woodland or the forest stand ELC ecosite containing the colony.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in bat maternity colony SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where bat activity is lowest.

Timing is another possible mitigation option. Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally (Mitchell-Jones 2004). Short-term activities should be scheduled for when bats are absent.

Where vegetation needs to be cleared for a residential or commercial development, avoid removing protective forest cover leading to maternity colonies. This cover facilitates the movement of bats to and from these sites. If site characteristics are altered, the ecological function of the site may be reduced or lost. Habitat disturbed during construction should be fully restored to a functional state once construction is completed (OMNR 2011).

The preservation of bat foraging habitats is also very important. Obstruction or destruction of foraging areas may prove to be disastrous, especially if a bat species displays very narrow feeding requirements or exhibits strong site foraging fidelity. It should be noted, however, that creation of small openings in extensive forest (e.g., single lot development) may improve foraging habitat for bats (Grindal and Brigham 1998; Arnett et al. 2005).

It may be possible to mitigate the loss or degradation of maternity roost habitat (e.g., forests, human structures) by providing a bat house. Design and placement are critically important if the structure is going to attract and sustain a maternity colony. Bats are very selective about their roosting habitat, and maternity colony sites need to be large enough to accommodate many female bats and their pups. Commercially available bat houses tend to be too small for this purpose, and at best end up sheltering only small numbers of male bats (Tatarian 2001). Information about building successful bat houses can be found through Bat Conservation International's Bat House Research Project (BCI 2010).

Human activity tends to increase in areas developed for residential and commercial use. Steps will need to be taken to prevent human access to maternity colonies where possible (e.g., when these occur in discrete features such as abandoned mines and buildings). Where feasible, trails and roads that lead to maternity colony sites should be blocked or allowed to deteriorate (Brady et al. 1983). If development is planned in groundwater recharge areas near maternity colony sites, hydro-geological studies should be completed to demonstrate that moisture regimes will not be affected.

MAJOR RECREATIONAL DEVELOPMENTS

Maternity Colonies

Potential Development Effects

Ski resorts, cave commercialization and golf course developments all have the potential to affect maternity colonies.

Site alterations which result in the loss of vegetation can reduce the ecological function of bat maternity colonies. Deforestation near maternity colony sites and between these sites and feeding areas may result in decreased prey availability (Barclay 1984), decreased foraging efficiency, and increased vulnerability to predators (Tuttle 1979). Since suitable maternity colony sites are limited, the loss of any site has significant impacts on bat populations.

Developments which result in significant forest clearing will impact nursery colonies of those bats which nurse in forested areas (or in the crevices of rocks therein). Old buildings, such as old houses, barns and abandoned structures often serve as maternity roosts, so bats will be negatively affected if they are razed. For example, Big Brown Bats frequently form nursery colonies in buildings; a major cause of population decline in these species is extermination of these nursery colonies. Humphrey (1982) suggested that most Little Brown Myotis that are excluded from their nursery roosts disperse, but presumably die since marked animals do not return to their traditional hibernation sites.

Recreational development near bat maternity colonies will likely increase human disturbance at these sites. Some bat species are known to abandon summer roosts because of human disturbance (Barbour and Davis 1969). Human disturbance near bat maternity colonies has also been known to cause female bats to drop their pups to the ground to flee from intruders, or to abandon their young altogether (Nolan 1997).

Mitigation Options

Development will not be permitted in bat maternity colony SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the habitat includes the entire woodland or the forest stand ELC ecosite containing the colony.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in bat maternity colony SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where bat activity is lowest.

Timing is another possible mitigation option. Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally (Mitchell-Jones 2004). Short-term activities should be scheduled for when bats are absent.

Where vegetation needs to be cleared for a major recreational development, avoid removing protective forest cover leading to maternity colonies. This cover facilitates the movement of bats to and from these sites. If site characteristics are altered, the ecological function of the site may be reduced or lost. Habitat disturbed during construction should be fully restored to a functional state once construction is completed (OMNR 2011).

The preservation of bat foraging habitats is also very important. Obstruction or destruction of foraging areas may prove to be disastrous, especially if a bat species displays very narrow feeding requirements or exhibits strong site foraging fidelity. It should be noted, however, that creation of small openings in extensive forest (e.g., single lot development) may improve foraging habitat for bats (Grindal and Brigham 1998; Arnett et al. 2005).

It may be possible to mitigate the loss or degradation of maternity roost habitat (e.g., forests, human structures) by providing a bat house. Design and placement are critically important if the structure is going to attract and sustain a maternity colony. Bats are very selective about their roosting habitat, and maternity colony sites need to be large enough to accommodate many female bats and their pups. Commercially available bat houses tend to be too small for this purpose, and at best end up sheltering only small numbers of male bats (Tatarian 2001). Information about building successful bat houses can be found through Bat Conservation International's Bat House Research Project (BCI 2010).

Human activity tends to increase in areas of major recreational development. Where feasible, trails and roads that lead to maternity colony sites should be blocked or allowed to deteriorate (Brady et al. 1983).
If development is planned in groundwater recharge areas near maternity colony sites, hydro-geological studies should be completed to demonstrate that moisture regimes will not be affected.

AGGREGATE AND MINE DEVELOPMENT

Maternity Colonies

Potential Development Effects

Site alterations which result in the loss of vegetation can reduce the ecological function of bat maternity colonies. Deforestation near maternity colony sites and between these sites and feeding areas may result in decreased prey availability (Barclay 1984), decreased foraging efficiency, and increased vulnerability to predators (Tuttle 1979). Since suitable maternity colony sites are limited, the loss of any site has significant impacts on bat populations.

Old buildings, such as old houses, barns and abandoned structures often serve as maternity roosts, so bats will be negatively affected if they are razed. For example, Big Brown Bats frequently form nursery colonies in buildings; a major cause of population decline in these species is extermination of these nursery colonies. Humphrey (1982) suggested that most bats that are excluded from their nursery roosts disperse, but presumably die since marked animals do not return to their traditional hibernation sites.

Aggregate and mine development near bat maternity colonies will likely increase human disturbance at these sites. Some bat species are known to abandon summer roosts because of human disturbance (Barbour and Davis 1969). Human disturbance near bat maternity colonies has also been known to cause female bats to drop their pups to the ground to flee from intruders, or to abandon their young altogether (Nolan 1997).

Mitigation Options

Development will not be permitted in bat maternity colony SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the habitat includes the entire woodland or the forest stand ELC ecosite containing the colony.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in bat maternity colony SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where bat activity is lowest.

Timing is another possible mitigation option. Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally (Mitchell-Jones 2004). Short-term activities should be scheduled for when bats are absent.

Where vegetation needs to be cleared for an aggregate or mine development, avoid removing protective forest cover leading to maternity colonies. This cover facilitates the movement of bats to and from these sites. If site characteristics are altered, the ecological function of the site may be reduced or lost. Habitat disturbed during construction should be fully restored to a functional state once construction is completed (OMNR 2011).

The preservation of bat foraging habitats is also very important. Obstruction or destruction of foraging areas may prove to be disastrous, especially if a bat species displays very narrow feeding requirements or exhibits strong site foraging fidelity. It should be noted, however, that creation of small openings in extensive forest (e.g., single lot development) may improve foraging habitat for bats (Grindal and Brigham 1998; Arnett et al. 2005).

It may be possible to mitigate the loss or degradation of maternity roost habitat (e.g., forests, human structures) by providing a bat house. Design and placement are critically important if the structure is going to attract and sustain a maternity colony. Bats are very selective about their roosting habitat, and maternity colony sites need to be large enough to accommodate many female bats and their pups. Commercially available bat houses tend to be too small for this purpose, and at best end up sheltering only small numbers of male bats (Tatarian 2001). Information about building successful bat houses can be found through Bat Conservation International's Bat House Research Project (BCI 2010).

Aggregate and mining developments result in increased human activity at all times of the year. Where feasible, trails and roads that lead to maternity colony sites should be blocked or allowed to deteriorate (Brady et al. 1983). If development is planned in groundwater recharge areas near maternity colony sites, hydro-geological studies should be completed to demonstrate that moisture regimes will not be affected.

ENERGY DEVELOPMENT

Maternity Colonies

Potential Development Effects: Wind Power Facilities

High levels of bat activity should be expected in and around bat maternity colonies, particularly during the lactation period (Henry et al. 2002). Wind turbines near these features have the potential to cause significant bat mortality. Direct impacts include mortality due to nocturnal collisions with wind turbine blades and to barotrauma caused by a rapid reduction in air pressure near moving turbine blades. Indirect impacts arise from habitat loss or fragmentation, and displacement from suitable habitat due to human activity or noise (OMNR 2011). Additionally, bat habitat may be directly impacted by the footprint of turbines, roads, maintenance yards, transmission lines and auxiliary buildings. Deforestation associated with the installation of these structures can remove woodland habitat important to breeding or roosting bats (OMNR 2011).

Some researchers have postulated that lights at wind power facilities may attract bats because of increased insect activity (Furlonger et al. 1987; Kunz 2004), but Horn and Arnett (2005), Johnson (2004), and Arnett et al. (2008) reported no difference in bat mortality at lit versus unlit towers. Mortality is also greater with increasing turbine height (Barclay et al. 2007). Increased mortality may also occur with decreasing wind velocity (Horn et al. 2008), with most bats killed when winds are less than 6 km/hour (Arnett et al. 2008). Bats do not appear to avoid the rotating blades of a turbine (OMNR 2011).

In an Alberta study, direct contact with turbine blades accounted for 50% of the bat fatalities recorded, and barotrauma was the cause of death in the other 50% (Baerwald et al. 2008). However, 90% of the fatalities showed evidence of internal haemorrhaging consistent with barotrauma, even where the apparent cause of death was physical trauma.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of bat maternity colony SWH should be avoided. The SWH includes the forested ELC ecosite that contains the colony, so this distance is measured from the edge of the ecosite to the tip of the turbine blade when it is rotated toward the habitat (as opposed to from the base of the turbine). For example, a 500 ha woodlot may contain a bat maternity colony within a 30 ha section of FOD1; the 120 m setback distance must be measured from the outer edge of the FOD1 ecosite. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the maternity colony or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in bat maternity colony SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where bat activity is lowest.

Timing is another possible mitigation option. Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally (Mitchell-Jones 2004). If short-term activities occurring in close proximity to maternity roosting sites are scheduled when bats are absent or not nursing young (September-April), the bats are less likely to be disturbed. Habitat disturbed during construction should be fully restored to a functional state once construction is completed (OMNR 2011).

Barclay et al. (2007) determined that bat fatalities increased exponentially with tower height, so minimizing tower height of turbines could significantly reduce bat fatalities. Consideration should also be given to shutting turbines down at night during the maternity period and/or when wind velocities are less than 6 km/hour. This can be accomplished by changing the cut-in speed, or altering the pitch angle of the blades to reduce rotor speed. These measures reduced bat fatalities in a southern Alberta study by 57.5% and 60.0% respectively (Baerwald et al. 2009). In Pennsylvania, decreased cut-in speeds reduced bat mortality by 53-87% with marginal annual power losses (Arnett et al. 2009).

Potential Development Effects: Solar Power Facilities

Site alterations which result in the loss of vegetation can reduce the ecological function of bat maternity colonies. Deforestation near maternity colony sites and between these sites and feeding areas may result in decreased prey availability (Barclay 1984), decreased foraging efficiency, and increased vulnerability to predators (Tuttle 1979). Since suitable maternity colony sites are limited, the loss of any site has significant impacts on bat populations.

Developments which result in significant forest clearing will impact nursery colonies of those bats which nurse in forested areas (or in the crevices of rocks therein). Old buildings, such as old houses, barns and abandoned structures often serve as maternity roosts, so bats will be negatively affected if they are razed. For example, Big Brown Bats frequently form nursery colonies in buildings; a major cause of population decline in these species is extermination of these nursery colonies. Humphrey (1982) suggested that most bats that are excluded from their nursery roosts disperse, but presumably die since marked animals do not return to their traditional hibernation sites.

Development near bat maternity colonies may increase human disturbance at these sites. Some bat species are known to abandon summer roosts because of human disturbance (Barbour and Davis 1969). Human disturbance near bat maternity colonies has also been known to cause female bats to drop their pups to the ground to flee from intruders, or to abandon their young altogether (Nolan 1997).

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of bat maternity colony SWH should be avoided. The SWH includes the forested ELC ecosite that contains the colony. For example, a 500 ha woodlot may contain a bat maternity colony within a 30 ha section of FOD1; the 120 m setback distance must be measured from the outer edge of the FOD1 ecosite. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the maternity colony or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. The project should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in bat maternity colony SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where bat activity is lowest.

Where vegetation needs to be cleared for development, avoid removing protective forest cover leading to maternity colonies. This cover facilitates the movement of bats to and from these sites. If site characteristics are altered, the ecological function of the site may be reduced or lost. Habitat disturbed during construction should be fully restored to a functional state once construction is completed (OMNR 2011).

The preservation of bat foraging habitats is also very important. Obstruction or destruction of foraging areas may prove to be disastrous, especially if a bat species displays very narrow feeding requirements or exhibits strong site foraging fidelity.

It may be possible to mitigate the loss or degradation of maternity roost habitat (e.g., forests, human structures) by providing a bat house. Design and placement are critically important if the structure is going to attract and sustain a maternity colony. Bats are very selective about their roosting habitat, and maternity colony sites need to be large enough to accommodate many female bats and their pups. Commercially available bat houses tend to be too small for this purpose, and at best end up sheltering only small numbers of male bats (Tatarian 2001). Information about building successful bat houses can be found through Bat Conservation International's Bat House Research Project (BCI 2010).

Human activity tends to increase in developed areas (e.g., construction workers, maintenance crews, traffic on access roads). Where feasible, trails and roads that lead to maternity colony sites should be blocked or allowed to deteriorate (Brady et al. 1983). If development is planned in groundwater recharge areas near maternity colony sites, hydro-geological studies should be completed to demonstrate that moisture regimes will not be affected.

ROAD DEVELOPMENT

Maternity Colonies

Potential Development Effects

Road construction may impact bat maternity colonies by destroying forest habitat which includes tree hollows used as nurseries. Bats may also roost under loose bark with their young. Mature forests, especially those with rocks offering crevices, are often preferred by bats. Proximity to water bodies is important to some species.

Road construction near bat maternity colonies may increase human disturbance of the bats at these sites. Human disturbance near bat maternity colonies has been known to cause female bats to drop their pup to the ground to flee from intruders, or to abandon their young altogether.

Construction of new roads through extensively forested areas may make the site more attractive for foraging for bats (Grindal and Brigham 1998; Arnett et al. 2005).

Mitigation Options

Development will not be permitted in bat maternity colony SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the habitat includes the entire woodland or the forest stand ELC ecosite containing the colony.

Site selection is typically an important component of a successful mitigation strategy. Development should always be directed away from maternity colonies. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in bat maternity colony SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where bat activity is lowest.

Timing is another possible mitigation option. Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally (Mitchell-Jones 2004). Short-term activities should be scheduled for when bats are absent.

Where vegetation needs to be cleared for a road development, avoid removing protective forest cover leading to maternity colonies. This cover facilitates the movement of bats to and from these sites. If site characteristics are altered, the ecological function of the site may be reduced or lost. Habitat disturbed during construction should be fully restored to a functional state once construction is completed (OMNR 2011).

The preservation of bat foraging habitats is also very important. Obstruction or destruction of foraging areas may prove to be disastrous, especially if a bat species displays very narrow feeding requirements or exhibits strong site foraging fidelity. It should be noted, however, that creation of small openings in extensive forest (e.g., single lot development) may improve foraging habitat for bats (Grindal and Brigham 1998; Arnett et al. 2005).

It may be possible to mitigate the loss or degradation of maternity roost habitat (e.g., forests, human structures) by providing a bat house. Design and placement are critically important if the structure is going to attract and sustain a maternity colony. Bats are very selective about their roosting habitat, and maternity colony sites need to be large enough to accommodate many female bats and their pups. Commercially available bat houses tend to be too small for this purpose, and at best end up sheltering only small numbers of male bats (Tatarian 2001). Information about building successful bat houses can be found through Bat Conservation International's Bat House Research Project (BCI 2010).

Human activity tends to increase in areas where roads are developed. Where feasible, trails and roads that lead to maternity colony sites should be blocked or allowed to deteriorate (Brady et al. 1983).

If development is planned in groundwater recharge areas near maternity colony sites, hydro-geological studies should be completed to demonstrate that moisture regimes will not be affected.

INDEX #13: REPTILE HIBERNACULA (TERRESTRIAL)

Ecoregions:	All of Ontario
Species Group:	Snakes: Eastern Garter Snake, Brown Snake, Smooth Green Snake, Northern Ringneck Snake, Northern Water Snake, Northern Redbelly Snake, Eastern Milksnake (SPECIAL CONCERN), Northern Ribbonsnake (SPECIAL CONCERN),
Lizards:	Five-lined Skink, Southern Shield population (SPECIAL CONCERN)
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Snake Hibernacula
Habitat Features:	Rock piles or slopes, stone fences, crumbling foundations The Massasauga (THREATENED), the Eastern Hog-nosed Snake (THREATENED), the Blue Racer (ENDANGERED), the Gray Ratsnake, Carolinian population (ENDANGERED), the Gray Ratsnake, Frontenac Axis population (THREATENED) and Caroinian population (ENDANGERED), the Timber Rattlesnake (EXTIRPATED), and the Five-lined Skink, Carolinian population (ENDANGERED) are protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that may affect these species.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

The ability of reptiles to overwinter successfully in cold climates can have a large impact on population persistence (COSEWIC 2007). Snakes depend on hibernation sites located below frost lines in burrows, rock crevices and other natural locations to escape freezing temperatures. An abundance of such sites is needed to ensure overwinter survival. The accumulation of rock and wood at the base of cliffs provides crevices and other structures suitable for hibernation. Areas of broken and fissured rock are particularly valuable since they provide access to subterranean sites below the frost line. Hibernacula may also occur in areas where bedrock is near the surface, and these areas may support a variety of vegetation communities including cultural meadows and thickets as well as forest. The access to subterranean crevices is much more important than the vegetation communities that are present. Access to these areas may be through fissures in the rock, along tree roots, or through mammal burrows. It is possible that seeps and springs are potentially important hibernation sites for some snake species such as the Northern Ribbonsnake.

The Five-lined Skink is Ontario's only lizard. It is semi-fossorial (is an effective burrower, and spends as lot of time under cover), appears to have a limited home range (Powell and Russell 2007), and has a tendency to aggregate together (Seburn 1993; Powell and Russell 2007), including during hibernation (Environment Canada 2007b). Five-lined Skinks are found in two rather different habitat settings in Ontario. Skinks occur among the sandy beaches and dunes of Lake Erie and Lake Huron shorelines and adjacent woods (Carolinian population) as well as in barren rock/woodland settings of the southern Canadian Shield (Oldham and Weller 2000; Environment Canada 2007b). Five-lined skinks in southwestern Ontario are known to use a variety of hibernation sites, such as under logs or rocks, in decaying stumps and fallen timber, and underground beneath wood debris in sand dune habitat (COSEWIC 2007; Environment Canada 2007b), but knowledge about site characteristics (e.g., moisture level, temperature range) is lacking (COSEWIC 2007). Downed woody debris and light sandy soil are very significant habitat elements. Skinks in central Ontario prefer moist woods with rocky outcrops of granite, limestone and basalt where crevices and loose rock provide both cover and basking opportunities (Seburn 1990, in Cameron 2007; Powell and Russell 2007). Skinks are found frequently under logs, deep leaf litter, rocks, sawdust piles, etc., and hibernate in rotting logs or as much as 2.5 m underground (below the frost line) (COSEWIC 2007). The Shield population also uses artificial habitat components such as garbage dumps and cottage structures. Abundant cover is the critical habitat feature for these skinks (Powell and Russell 2007).

Many snakes overwinter in Ontario in communal hibernacula (Konze and McLaren 1997). Some hibernacula may be used by many individuals; others may be used by only 1 or 2 individuals, but may still be significant if the species is of conservation concern. Five-lined skinks show significant aggregation behaviour at all times of the year, but especially so during hibernation; Cooper and Gartska (1987, in COSEWIC 2007) speculate that there may be a thermal benefit to this behaviour.

Talus slopes are most likely to be used as hibernacula by some of the more common and small snakes than the larger species. Nonetheless, these larger species also have the potential to occur at the base of cliffs among rocks. For some species, the necessary characteristics for hibernacula are not well known so it is not possible to predict with any accuracy where snakes will overwinter.

Reptiles may be particularly sensitive to changes in structural microhabitat features; such structures can often directly influence microclimatic conditions important for over-wintering, especially at higher latitudes (Rosen 1991, in Howes and Lougheed 2004). Consequently, the subterranean portion of snake hibernacula may be very complex. Work on Red-sided Garter Snakes has demonstrated that the snakes were active in winter and moved vertically in response to temperatures within the hibernaculum. This particular hibernacula supported approximately 35,000 snakes and was characterised by a complex structure of underground passageways and fissures (Gregory 1977; Lutterschmidt et al. 2006). This complexity may be typical of good snake hibernacula regardless of species, as a complex subterranean area allows snakes to respond to changes in temperature and moisture regimes. This complexity needs to be taken into account when predicting impacts on existing hibernacula and when constructing artificial hibernacula.

Potential Development Effects and Mitigation Options

Development may affect a number of hibernacula or the effectiveness of hibernacula if it involves the area of accumulated rock and woody debris at the base of cliffs, significantly reduces forest size, or removes logs and other debris on the forest floor. Hibernacula in more open habitats can be destroyed if development occurs over them. New roads bisecting connectivity corridors used during seasonal migration to/from hibernacula (or increased development-related traffic on existing roads) may result in population losses due to road kill. Changes to local hydrology or hydrogeology can be devastating, either drowning out or desiccating hibernating snakes and skinks. Trails or other access placed near known communal hibernating sites can jeopardize populations of snakes from persecution or collection as well.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

The biggest threat to the Shield population of Five-lined Skinks is habitat loss due to the development of land for cottages and recreational trail use. Urbanization also increases the threat of illegal collecting for the pet trade, depredation by dogs, cats and raccoons, and road mortality (COSEWIC 2007).

Lot clearing, excavation, construction and road building activities present considerable risk to hibernating snakes and skinks. Development that removes woody debris and other suitable cover elements from the landscape has been shown in southwestern Ontario to have a detrimental impact on Five-lined Skinks (Hecnar and M'Closkey 1998). Increased human usage can have negative impacts on skink habitat. Degradation of vegetation and loss of ground structure may occur, and structural loss may reduce habitat suitability for skinks. Since the distribution of skink populations tends to be patchy, development in areas where skinks are abundant can potentially affect an entire local population. Development on adjacent land is not expected to directly affect skink populations in their preferred habitat, unless it affects moisture regimes in preferred habitat.

For snakes, development in adjacent lands can result in mortality as large numbers of individuals (in some cases) try to move to the hibernaculum. As the forest canopy is opened up, the microclimate of the forest interior becomes more variable. If this results in extreme temperature fluctuations within hibernacula, over-winter survival may be reduced for both snakes and skinks. The effects of these habitat changes may only be realized in the most severe winters. From a population standpoint, the effect can be devastating, with large-scale winter mortality eliminating any accumulation in numbers in a single season.

Excavation, road building and construction can easily destroy quality hibernacula by preventing access to subterranean resting sites. These activities may also permanently remove active sites from the area. Loss of these habitat features usually goes undetected since it is very difficult to recognize hibernacula using ground surface cues and since reptiles themselves tend to be secretive. These activities also have the potential to result in the collapse of underground structures that are important to wintering snakes and skinks. Removal of topsoil from areas above hibernacula may result in deeper frost penetration making the site less suitable.

When hibernation sites are lost in an area, snakes and skinks are forced to select alternate sites. Many such sites will not provide sufficient protection from the extremes of winter weather or there may be no nearby suitable hibernacula. Reptiles which find themselves in marginal sites for the winter are at risk of winter mortality and susceptible to predation. If the majority of quality hibernacula are eliminated there can be serious impacts on reptile populations and their long-term persistence. Most species have little to no flexibility with respect to finding alternate sites. Some snake species, especially the larger ones (most of which are Species at Risk), are extremely faithful to one site, having used the same site for many generations. The loss of one such site could mean local extirpation of a population or sub-population or result in the loss of dozens of older breeding adults.

Development that affects the underground moisture regime has the potential to affect snake and skink hibernacula. Some species are sensitive to humidity levels and reduction in moisture may result in desiccation. Conversely, if the water table is increased, individuals may drown or there may be insufficient area between the water table and the frost line to support them through the winter.

Road construction near hibernacula may increase reptile mortality. As reptiles migrate to hibernacula they often rest on roadways taking advantage of the heat road surfaces provide. Many may be killed by cars. Increased road mortality can affect the viability of small isolated populations. Also, large-scale developments which sever habitat linking summer range and hibernacula will prevent individuals from reaching traditional winter areas. Development may eliminate or reduce habitat critical in other seasons, or interrupt migration routes.

Many humans have an aversion to snakes. Larger snakes may be intentionally killed by people, and even small, harmless snakes may be at risk (Ashley et al. 2007). As the number of people increases (e.g., due to residential development), so does the likelihood of people-snake interactions, and many snakes may be destroyed. Subsequent lot clearing and landscaping can further degrade the habitat.

Mitigation Options

A 30 m radius centred around the hibernaculum is the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development in reptile hibernacula SWH has the potential to physically damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, the development should retain habitat elements that will preserve functionality as hibernacula. For Five-lined Skinks, woody debris, corridors to and from the habitat, rocks and other suitable cover elements on the landscape should be retained (Hecnar and M'Closkey 1998).

For snake hibernacula, a suitable buffer should always be established around the site. The buffer needs to take into account the fact that the hibernaculum may extend laterally for some distance underground. Many communally hibernating snake species will "stage" in the spring and autumn for several days to a couple of weeks in the vicinity of the hibernation site during which time they engage in critical thermoregulation, mating, and ecdysis (shedding), and need shelter cover from predators and weather extremes. For the Gray Ratsnake, for example, these activities take place within 75-100 m of the entrance to the hibernaculum. Development should never occur within this buffer area for any hibernacula, and heavy equipment should not be allowed on it. This could result in collapse of the important underground features. Additionally, topsoil should never be removed in this area because it could affect the depth to which frost penetrates, thereby reducing the effectiveness of the hibernaculum in protecting wintering snakes. Care needs be taken to avoid snow compaction above or in the vicinity of known hibernacula as this can reduce the insulation value of snow cover and permit deeper frost penetration.

Sufficient hydro-geological work should be undertaken to understand the level of the water table adjacent to snake and skink hibernacula and how it may be affected by the proposed development. Suitable mitigation will be required to ensure that there are no significant changes in the water table near the hibernaculum or in the timing of changes in the groundwater levels. Potential mitigation could include reducing the amount of area developed to minimize the area that is impervious, running roof leaders to swales, using porous stones and bricks in driveways instead of asphalt and cement, and infiltrating stormwater where possible.

Steps should be taken to control speed on roads in the vicinity of hibernacula. Signage and public education programs may help to prevent excessive road mortality and mortality at the hands of humans. At Long Point, however, signage has been ineffective in reducing road mortality and a small percentage of motorists deliberately run over snakes (Ashley et al. 2007). Speed humps could be installed in areas to control vehicle speeds.

In some cases, underpasses, culverts, or tunnels for snakes may be effective. Road underpasses for snakes have to be well designed in order to be effective. For the most part, snakes prefer to cross over the road because it will be warmer than going through a culvert or tunnel. Therefore, it may be necessary to create a barrier so that snakes cannot access the upper surface of the road.

There may also be opportunities to construct snake hibernacula, as described by the Ontario Ministry of Natural Resources (OMNR 2008b); however, the construction of snake hibernacula must always be a last resort to protection of natural hibernacula. When designing a hibernacula, several factors should be considered. In addition to the habitat requirements of the species in question, these include the water table depth, depth to bedrock, depth of frost penetration in winter, and whether the structure will be built above or under ground. Other considerations are the type and size of rocks or other material that will be used to construct the hibernaculum, the type of material used to cover it, whether or not it should be vegetated, and the type and orientation of entrance holes. Most designs have entrance holes that are far too large, and these are not attractive to snakes and the large entrance holes may result in cold air penetrating well into the hibernaculum and ingress by small mammalian predators. Entrances to natural snake hibernacula are typically inconspicuous and usually of very small diameter so that the snake has to squeeze to get inside.

If artificial hibernacula are being built, thought needs to be given to providing other key habitat features for the species in question. For snakes, these features could include hot rocks for basking and cover, brush piles for shedding and thermoregulation, and potential nesting sites. All of these should be provided within a small area to minimize the home range size of the snakes and therefore their exposure due to crossing roads and other areas that may increase the risk of mortality. Five-lined skinks have been shown to colonize and use experimental debris, at least during the active season, and to be tolerant to minor disturbances but not to removal or degradation of cover debris (Hecnar and M'Closkey 1998). Essential microhabitat features must be actively preserved as well as suitable habitat to ensure the conservation of this species.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Snake hibernacula could potentially be affected by all types of major recreational development: golf courses, golf course communities, ski resorts, and marinas. Five-lined Skinks could potentially be affected by golf course development, golf course communities, and ski resorts.

Golf course development converts habitat into manicured areas. Depending on the location of critical skink habitats in relation to golf course holes, the manicured fairways could potentially be a barrier to movement among habitats. Cutting of swathes through forested habitat could destroy habitat and result in removal of woody debris and other structures that may serve as hibernacula. Opening forest cover could also make the area drier and less suitable for skinks. Development of ski slopes has the same potential to affect the Five-lined Skink by creating linear openings in forested cover. The removal of rocks at the base of the ski slope may also impact skinks by reducing potential structure for hibernacula.

All clearing, excavation, construction and road building activities present considerable risk to hibernating snakes and skinks. Development that removes woody debris and other suitable cover elements from the landscape has been shown in southwestern Ontario to have a detrimental impact on Five-lined Skinks (Hecnar and M'Closkey 1998). Increased human usage can have negative impacts on skink habitat. Degradation of vegetation and loss of ground structure may occur, and structural loss may reduce habitat suitability for skinks. Since the distribution of skink populations tends to be patchy, development in areas where skinks are abundant can potentially affect an entire local population. Development on adjacent land is not expected to directly affect skink populations in their preferred habitat, unless it affects moisture regimes in preferred habitat. For snakes, development in adjacent lands can result in mortality as large numbers of individuals (in some cases) try to move to hibernacula. As the forest canopy is opened up, the microclimate of the forest interior becomes more variable. If this results in extreme temperature fluctuations within hibernacula, over-winter survival may be reduced for both snakes and skinks. The effects of these habitat changes may only be realized in the most severe winters. From a population standpoint, the effect can be devastating, with large-scale winter mortality eliminating any accumulation in numbers in a single season.

Excavation and construction can easily destroy quality hibernacula by preventing access to subterranean resting sites. These activities may also permanently remove active sites from the area. Loss of these habitat features usually goes undetected since it is very difficult to recognize hibernacula using ground surface cues and since reptiles themselves tend to be secretive. These activities also have the potential to result in the collapse of underground structures that are important to wintering snakes. Removal of topsoil from areas above a hibernacula may result in deeper frost penetration making the site less suitable.

When hibernation sites are lost in an area, snakes and skinks are forced to select alternate sites. Many such sites will not provide sufficient protection from the extremes of winter weather or there may be no nearby suitable hibernacula. Reptiles which find themselves in marginal sites for the winter are at risk of winter mortality and susceptible to predation. If the majority of quality hibernacula are eliminated there can be serious impacts on reptile populations and their long-term persistence. Most species have little to no flexibility with respect to finding alternate sites. Some snake species, especially the larger ones (most of which are Species at Risk), are extremely faithful to one site, having used the same site for many generations. The loss of one such site could mean local extirpation of a population or sub-population or result in the loss of dozens of older breeding adults.

Development that affects the underground moisture regime has the potential to affect snake and skink hibernacula. Some species are sensitive to humidity levels and reduction in moisture may result in desiccation. Conversely, if the water table is increased, individuals may drown or there may be insufficient area between the water table and the frost line to support them through the winter.

Mitigation Options

A 30 m radius centred around the hibernaculum is the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development in reptile hibernacula SWH has the potential to physically damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, the development should retain habitat elements that will preserve functionality as hibernacula. For Five-lined Skinks, woody debris, corridors to and from the habitat, rocks and other suitable cover elements on the landscape should be retained (Hecnar and M'Closkey 1998).

For snake hibernacula, a suitable buffer should always be established around the site. The buffer needs to take into account the fact that the hibernaculum may extend laterally for some distance underground. Many communally hibernating snake species will "stage" in the spring and autumn for several days to a couple of weeks in the vicinity of the hibernation site during which time they engage in critical thermoregulation, mating, and ecdysis (shedding), and need shelter cover from predators and weather extremes. For the Gray Ratsnake, for example, these activities take place within 75-100 m of the entrance to the hibernaculum. Development should never occur within this buffer area for any hibernacula, and heavy equipment should not be allowed on it. This could result in collapse of the important underground features. Additionally, topsoil should never be removed in this area because it could affect the depth to which frost penetrates, thereby reducing the effectiveness of the hibernaculum in protecting wintering snakes. Care needs be taken to avoid snow compaction above or in the vicinity of known hibernacula as this can reduce the insulation value of snow cover and permit deeper frost penetration.

Sufficient hydro-geological work should be undertaken to understand the level of the water table adjacent to snake and skink hibernacula and how it may be affected by the proposed development. Suitable mitigation will be required to ensure that there are no significant changes in the water table near the hibernaculum or in the timing of changes in the groundwater levels. Potential mitigation could include minimizing the area that is impervious, directing runoff from buildings to swales, using porous road/parking lot surfaces, and infiltrating stormwater where possible.

There may also be opportunities to construct snake hibernacula, as described by the Ministry of Natural Resources (OMNR 2008b); however, the construction of snake hibernacula must always be a last resort to protection of natural hibernacula. When designing a hibernacula, several factors should be considered. In addition to the habitat requirements of the species in question, these include the water table depth, depth to bedrock, depth of frost penetration in winter, and whether the structure will be built above or under ground. Other considerations are the type and size of rocks or other material that will be used to construct the hibernaculum, the type of material used to cover it, whether or not it should be vegetated, and the type and orientation of entrance holes. Most designs have entrance holes that are far too large, and these are not attractive to snakes and the large entrance holes may result in cold air penetrating well into the hibernaculum and ingress by small mammalian predators. Entrances to natural snake hibernacula are typically inconspicuous and usually of very small diameter so that the snake has to squeeze to get inside.

If artificial hibernacula are being built, thought needs to be given to providing other key habitat features for the species in question. For snakes, these features could include hot rocks for basking and cover, brush piles for shedding and thermoregulation, and potential nesting sites. All of these should be provided within a small area to minimize the home range size of the snakes and therefore their exposure due to crossing roads and other areas that may increase the risk of mortality. Five-lined skinks have been shown to colonize and use experimental debris, at least during the active season, and to be tolerant to minor disturbances but not to removal or degradation of cover debris (Hecnar and M'Closkey 1998). Essential microhabitat features must be actively preserved as well as suitable habitat to ensure the conservation of this species.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Quarry development is most likely to affect hibernacula for the Canadian Shield population of Five-lined Skinks. This population occurs in barren rock/woodland habitat (Oldham and Weller 2000) that is attractive for aggregate extraction where there is little overburden. Quarry development also has the potential to affect snake hibernacula. For both snakes and skinks, excavation can easily destroy hibernacula by preventing access to subterranean resting sites or through direct removal of the rock. These activities may also permanently remove active sites from the area. Loss of these habitat features usually goes undetected since it is very difficult to recognize hibernacula using ground surface cues and since reptiles themselves tend to be secretive.

When hibernation sites are lost in an area, snakes and skinks are forced to select alternate sites. Many such sites will not provide sufficient protection from the extremes of winter weather or there may be no nearby suitable hibernacula. Reptiles which find themselves in marginal sites for the winter are at risk of winter mortality and susceptible to predation. If the majority of quality hibernacula are eliminated there can be serious impacts on reptile populations and their long-term persistence. Most species have little to no flexibility with respect to finding alternate sites. Some snake species, especially the larger ones (most of which are Species at Risk), are extremely faithful to one site, having used the same site for many generations. The loss of one such site could mean local extirpation of a population or sub-population or result in the loss of dozens of older breeding adults.

Snakes have been shown to move around within hibernacula, apparently in response to small changes in moisture and temperature. Dewatering activities associated with resource extraction have the potential to drawdown the water table in the vicinity of hibernacula. This may affect the internal moisture regime in hibernacula and make them less suitable as wintering habitat.

Blasting has the potential to cause rock cavities used for hibernacula to collapse. Driving heavy equipment over hibernacula has the potential to crush underground cavities, which can not only kill resident snakes and skinks, but also destroy the subterranean features that are important to wintering snakes.

Mitigation Options

A 30 m radius centred around the hibernaculum is the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development in reptile hibernacula SWH has the potential to physically damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, the development should retain habitat elements that will preserve functionality as hibernacula. For Five-lined Skinks, woody debris, corridors to and from the habitat, rocks and other suitable cover elements on the landscape should be retained (Hecnar and M'Closkey 1998).

For snake hibernacula, a suitable buffer should always be established around the site. Buffers need to take into account the fact that snake hibernacula may extend laterally for some distance underground. Many communally hibernating species will "stage" in the spring and autumn for several days to a couple of weeks in the vicinity of the hibernation site during which time they engage in critical thermoregulation, mating, and ecdysis (shedding), and need shelter cover from predators and weather extremes. For the Gray Ratsnake, for example, these activities take place within 75-100 m of the entrance to the hibernaculum. A blasting study should be conducted to determine the required buffer from the hibernaculum to ensure that rock does not crumble in or in the immediate vicinity of the hibernaculum. Additionally, excavation should never occur within the buffer area for any hibernacula, and heavy equipment should not be allowed on it. This could result in collapse of the important underground features. Additionally, topsoil should never be removed in this area because it could affect the depth to which frost penetrates, thereby reducing the effectiveness of the hibernaculum in protecting wintering snakes. Care needs be taken to avoid snow compaction above or in the vicinity of known hibernacula as this can reduce the insulation value of snow cover and permit deeper frost penetration.

Sufficient hydro-geological work should be undertaken to understand the level of the water table adjacent to the hibernaculum and how it may be affected by the quarry or mine. Suitable mitigation will be required to ensure that there are no significant changes in the water table near the hibernaculum or in the timing of changes in the groundwater levels. Potential mitigation could include grouting so that the water table is not lowered, cessation of dewatering activities while the hibernaculum is active, or installation of recharge wells to maintain the water level. The latter mitigation measure has been recommended for several quarries, but its efficacy has yet to be tested.

There may also be opportunities to construct snake hibernacula, as described by the Ministry of Natural Resources (OMNR 2008b); however, the construction of snake hibernacula must always be a last resort to protection of natural hibernacula. When designing a hibernacula, several factors should be considered. In addition to the habitat requirements of the species in question, these include the water table depth, depth to bedrock, depth of frost penetration in winter, and whether the structure will be built above or under ground. Other considerations are the type and size of rocks or other material that will be used to construct the hibernaculum, the type of material used to cover it, whether or not it should be vegetated, and the type and orientation of entrance holes. Most designs have entrance holes that are far too large, and these are not attractive to snakes and the large entrance holes may result in cold air penetrating well into the hibernaculum and ingress by small mammalian predators. Entrances to natural snake hibernacula are typically inconspicuous and usually of very small diameter so that the snake has to squeeze to get inside.

If artificial hibernacula are being built, thought needs to be given to providing other key habitat features for the species in question. For snakes, these features could include hot rocks for basking and cover, brush piles for shedding and thermoregulation, and potential nesting sites. All of these should be provided within a small area to minimize the home range size of the snakes and therefore their exposure due to crossing roads and other areas that may increase the risk of mortality. Five-lined skinks have been shown to colonize and use experimental debris, at least during the active season, and to be tolerant to minor disturbances but not to removal or degradation of cover debris (Hecnar and M'Closkey 1998). Essential microhabitat features must be actively preserved as well as suitable habitat to ensure the conservation of this species.

Quarry rehabilitation also has the potential to create habitat for Five-linked Skinks (Cameron 2007), and this could include hibernacula. Site plans should identify areas where habitat will be provided for the skink and this should be a commitment that is part of the license requirements under the Aggregate Resources Act.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Excavation and construction can easily destroy quality hibernacula by preventing access to subterranean resting sites. These activities also have the potential to result in the collapse of underground structures that are important to wintering snakes. Removal of topsoil from areas above a hibernacula may result in deeper frost penetration making the site less suitable. Development that removes woody debris and other suitable cover elements from the landscape has been shown in southwestern Ontario to have a detrimental impact on Five-lined Skinks (Hecnar and M'Closkey 1998).

Snakes have been shown to move around within hibernacula, apparently in response to small changes in moisture and temperature. Clearing and construction can result in altered drainage patterns which may affect the internal moisture regime in hibernacula and make them less suitable as wintering habitat.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 150 m of hibernacula should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2); this distance incorporates the SWH around the hibernaculum plus a 120 m setback of adjacent land. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the hibernaculum or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2). Given the sensitivity of snake hibernacula, however, the negative impacts associated with developing a wind power facility within this SWH (i.e., less than 30 m from the centre) cannot be effectively mitigated. The Mitigation Options described below apply to the 120 m set-back allowance and beyond.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on reptiles and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development in reptile hibernacula SWH has the potential to physically damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, the development should retain habitat elements that will preserve functionality as hibernacula. For Five-lined Skinks, woody debris, corridors to and from the habitat, rocks and other suitable cover elements on the landscape should be retained (Hecnar and M'Closkey 1998).

For snake hibernacula, a suitable buffer should always be established around the site. The buffer needs to take into account the fact that the hibernaculum may extend laterally for some distance underground. Many communally hibernating snake species will "stage" in the spring and autumn for several days to a couple of weeks in the vicinity of the hibernation site during which time they engage in critical thermoregulation, mating, and ecdysis (shedding), and need shelter cover from predators and weather extremes. For the Gray Ratsnake, for example, these activities take place within 75-100 m of the entrance to the hibernaculum. Development should never occur within this buffer area for any hibernacula, and heavy equipment should not be allowed on it. This could result in collapse of the important underground features. Additionally, topsoil should never be removed in this area because it could affect the depth to which frost penetrates, thereby reducing the effectiveness of the hibernaculum in protecting wintering snakes. Care needs be taken to avoid snow compaction above or in the vicinity of known hibernacula as this can reduce the insulation value of snow cover and permit deeper frost penetration.

Avoid siting developments where they have the potential to interfere with access to/from hibernacula.

There may also be opportunities to construct snake hibernacula, as described by the Ministry of Natural Resources (OMNR 2008b); however, the construction of snake hibernacula must always be a last resort to protection of natural hibernacula. When designing a hibernacula, several factors should be considered. In addition to the habitat requirements of the species in question, these include the water table depth, depth to bedrock, depth of frost penetration in winter, and whether the structure will be built above or under ground. Other considerations are the type and size of rocks or other material that will be used to construct the hibernaculum, the type of material used to cover it, whether or not it should be vegetated, and the type and orientation of entrance holes. Most designs have entrance holes that are far too large, and these are not attractive to snakes and the large entrance holes may result in cold air penetrating well into the hibernaculum and ingress by small mammalian predators. Entrances to natural snake hibernacula are typically inconspicuous and usually of very small diameter so that the snake has to squeeze to get inside.

If artificial hibernacula are being built, thought needs to be given to providing other key habitat features for the species in question. For snakes, these features could include hot rocks for basking and cover, brush piles for shedding and thermoregulation, and potential nesting sites. All of these should be provided within a small area to minimize the home range size of the snakes and therefore their exposure due to crossing roads and other areas that may increase the risk of mortality. Five-lined skinks have been shown to colonize and use experimental debris, at least during the active season, and to be tolerant to minor disturbances but not to removal or degradation of cover debris (Hecnar and M'Closkey 1998). Essential microhabitat features must be actively preserved as well as suitable habitat to ensure the conservation of this species.

Potential Development Effects: Solar Power Facilities

Vegetation clearing, excavation, construction and road building activities present considerable risk to hibernating snakes and skinks. Development that removes woody debris and other suitable cover elements from the landscape has been shown in southwestern Ontario to have a detrimental impact on Five-lined Skinks (Hecnar and M'Closkey 1998). Where degradation of vegetation and loss of ground structure occur, habitat suitability for skinks will be reduced. Since the distribution of skink populations tends to be patchy, development in areas where skinks are abundant can potentially affect an entire local population. Development on adjacent land is not expected to directly affect skink populations in their preferred habitat, unless it affects moisture regimes in preferred habitat.

Excavation, road building and construction can easily destroy quality hibernacula by preventing access to subterranean resting sites. These activities may also permanently remove active sites from the area. Loss of these habitat features usually goes undetected since it is very difficult to recognize hibernacula using ground surface cues and since reptiles themselves tend to be secretive. These activities also have the potential to result in the collapse of underground structures that are important to wintering snakes and skinks. Removal of topsoil from areas above hibernacula may result in deeper frost penetration making the site less suitable.

When hibernation sites are lost in an area, snakes and skinks are forced to select alternate sites. Many such sites will not provide sufficient protection from the extremes of winter weather or there may be no nearby suitable hibernacula. Reptiles which find themselves in marginal sites for the winter are at risk of winter mortality and susceptible to predation. If the majority of quality hibernacula are eliminated there can be serious impacts on reptile populations and their long-term persistence. Most species have little to no flexibility with respect to finding alternate sites. Some snake species, especially the larger ones (most of which are Species at Risk), are extremely faithful to one site, having used the same site for many generations. The loss of one such site could mean local extirpation of a population or sub-population or result in the loss of dozens of older breeding adults.

Development that affects the underground moisture regime has the potential to affect snake and skink hibernacula. Some species are sensitive to humidity levels and reduction in moisture may result in desiccation. Conversely, if the water table is increased, individuals may drown or there may be insufficient area between the water table and the frost line to support them through the winter.

Road construction near hibernacula may increase reptile mortality. As reptiles migrate to hibernacula they often rest on roadways taking advantage of the heat road surfaces provide. Many may be killed by vehicles. Increased road mortality can affect the viability of small isolated populations. Also, large-scale developments which sever habitat linking summer range and hibernacula will prevent individuals from reaching traditional winter areas. Development may eliminate or reduce habitat critical in other seasons, or interrupt migration routes.

For snakes, development in adjacent lands can result in mortality as large numbers of individuals (in some cases) try to move to the hibernaculum. As the forest canopy is opened up, the microclimate of the forest interior becomes more variable. If this results in extreme temperature fluctuations within hibernacula, over-winter survival may be reduced for both snakes and skinks. The effects of these habitat changes may only be realized in the most severe winters. From a population standpoint, the effect can be devastating, with large-scale winter mortality eliminating any accumulation in numbers in a single season.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 150 m of hibernacula should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2); this distance incorporates the SWH around the hibernaculum plus a 120 m setback of adjacent land. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the hibernaculum or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2). Given the sensitivity of snake hibernacula, however, the negative impacts associated with developing a solar power facility within this SWH (i.e., less than 30 m from the centre) cannot be effectively mitigated. The Mitigation Options described below apply to the 120 m set-back allowance and beyond.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development in reptile hibernacula SWH has the potential to physically damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, the development should retain habitat elements that will preserve functionality as hibernacula. For Five-lined Skinks, woody debris, corridors to and from the habitat, rocks and other suitable cover elements on the landscape should be retained (Hecnar and M'Closkey 1998).

For snake hibernacula, a suitable buffer should always be established around the site. The buffer needs to take into account the fact that the hibernaculum may extend laterally for some distance underground. Many communally hibernating snake species will "stage" in the spring and autumn for several days to a couple of weeks in the vicinity of the hibernation site during which time they engage in critical thermoregulation, mating, and ecdysis (shedding), and need shelter cover from predators and weather extremes. For the Gray Ratsnake, for example, these activities take place within 75-100 m of the entrance to the hibernaculum. Development should never occur within this buffer area for any hibernacula, and heavy equipment should not be allowed on it. This could result in collapse of the important underground features. Additionally, topsoil should never be removed in this area because it could affect the depth to which frost penetrates, thereby reducing the effectiveness of the hibernaculum in protecting wintering snakes. Care needs be taken to avoid snow compaction above or in the vicinity of known hibernacula as this can reduce the insulation value of snow cover and permit deeper frost penetration.

Avoid siting developments where they have the potential to interfere with access to/from hibernacula.

Sufficient hydro-geological work should be undertaken to understand the level of the water table adjacent to snake and skink hibernacula and how it may be affected by the proposed development. Suitable mitigation will be required to ensure that there are no significant changes in the water table near the hibernaculum or in the timing of changes in the groundwater levels. Potential mitigation could include reducing the amount of area developed to minimize the area that is impervious, running roof leaders to swales, using porous stones and bricks in driveways instead of asphalt and cement, and infiltrating stormwater where possible.

There may also be opportunities to construct snake hibernacula, as described by the Ministry of Natural Resources (OMNR 2008b); however, the construction of snake hibernacula must always be a last resort to protection of natural hibernacula. When designing a hibernacula, several factors should be considered. In addition to the habitat requirements of the species in question, these include the water table depth, depth to bedrock, depth of frost penetration in winter, and whether the structure will be built above or under ground. Other considerations are the type and size of rocks or other material that will be used to construct the hibernaculum, the type of material used to cover it, whether or not it should be vegetated, and the type and orientation of entrance holes. Most designs have entrance holes that are far too large, and these are not attractive to snakes and the large entrance holes may result in cold air penetrating well into the hibernaculum and ingress by small mammalian predators. Entrances to natural snake hibernacula are typically inconspicuous and usually of very small diameter so that the snake has to squeeze to get inside.

If artificial hibernacula are being built, thought needs to be given to providing other key habitat features for the species in question. For snakes, these features could include hot rocks for basking and cover, brush piles for shedding and thermoregulation, and potential nesting sites. All of these should be provided within a small area to minimize the home range size of the snakes and therefore their exposure due to crossing roads and other areas that may increase the risk of mortality. Five-lined skinks have been shown to colonize and use experimental debris, at least during the active season, and to be tolerant to minor disturbances but not to removal or degradation of cover debris (Hecnar and M'Closkey 1998). Essential microhabitat features must be actively preserved as well as suitable habitat to ensure the conservation of this species.

ROAD DEVELOPMENT

Potential Development Effects

Road construction activities near hibernacula present considerable risk to hibernating snakes and skinks. Excavation can easily destroy quality hibernacula by preventing access to subterranean resting sites. These activities may also permanently remove active sites from the area. Loss of these habitat features usually goes undetected since it is very difficult to recognize hibernacula using ground surface cues and since reptiles themselves tend to be secretive. Blasting road cuts through bedrock and the use of heavy equipment have the potential to affect hibernacula both at the construction site and adjacent to it by destroying underground structures that are important to wintering snakes. Additionally, roads that sever habitat linking summer range and hibernacula will prevent individuals from reaching traditional winter areas.

Roads that affect the underground moisture regime have the potential to affect snake and skink hibernacula. Some species are sensitive to humidity levels and reduction in moisture may result in desiccation. Conversely, if the water table is increased, individuals may drown or there may be insufficient area between the water table and the frost line to support them through the winter. Roads frequently act as a dam to surface water flow and shallow groundwater resulting in higher water levels on one side of the road and lower levels on the other.

Road use near hibernacula can affect skinks through increased roadkill. In Point Pelee National Park, research has shown that road mortality of skinks is occurring, and the threat it represents has perhaps been underestimated (COSEWIC 2007). Snakes are also subject to roadkill as they migrate to and from hibernacula. During this process, individuals often rest on roadways to take advantage of the heat road surfaces provide. For both snakes and skinks, increased road mortality can affect the viability of small isolated populations. Near Kingston, Roe et al. (2007) found that Eastern Ratsnakes did not avoid crossing roads, and that roads caused significant mortality. Their estimate of road mortality was enough to increase the extinction probability for this population from 7.3% to 99% over 500 years.

Roads may be one of the more significant limiting factors to many snake populations. Andrews and Gibbons (2005) studied the behavioural responses of snakes to roads. They found that small snakes were much more likely to avoid crossing roads than large snakes. All snakes crossed the road perpendicularly thus minimizing exposure time to traffic. Crossing speeds varied considerably by species, with venomous snakes taking the longest to cross. Some species (Blue Racer and Eastern Ratsnake) froze when a vehicle approached, thus increasing their time on the road. Shepard et al. (2008) studied patterns of road kill of snakes in Illinois and found that most snake fatalities occurred in spring and autumn consistent with movement to and from hibernacula.

When hibernation sites are lost in an area, snakes and skinks are forced to select alternate sites. Many such sites will not provide sufficient protection from the extremes of winter weather or there may be no nearby suitable hibernacula. Reptiles which find themselves in marginal sites for the winter are at risk of winter mortality and susceptible to predation. If the majority of quality hibernacula are eliminated there can be serious impacts on reptile populations and their long-term persistence. Most species have little to no flexibility with respect to finding alternate sites. Some snake species, especially the larger ones (most of which are Species at Risk), are extremely faithful to one site, having used the same site for many generations. The loss of one such site could mean local extirpation of a population or sub-population or result in the loss of dozens of older breeding adults.

Mitigation Options

A 30 m radius centred around the hibernaculum is the SWH. Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development in reptile hibernacula SWH has the potential to physically damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, the development should retain habitat elements that will preserve functionality as hibernacula. For Five-lined Skinks, woody debris, corridors to and from the habitat, rocks and other suitable cover elements on the landscape should be retained (Hecnar and M'Closkey 1998).

If at all possible, roads should never be built where they will directly affect hibernacula. When complete avoidance is not possible, the development should establish and observe a buffer around hibernacula. Buffers need to take into account the fact that snake hibernacula may extend laterally for some distance underground. Many communally hibernating species will "stage" in the spring and autumn for several days to a couple of weeks in the vicinity of the hibernation site during which time they engage in critical thermoregulation, mating, and ecdysis (shedding), and need shelter cover from predators and weather extremes. For the Gray Ratsnake, for example, these activities take place within 75-100 m of the entrance to the hibernaculum. When blasting is planned, a blasting study should be conducted to determine the required buffer from the hibernaculum to ensure that rock does not crumble in or in the immediate vicinity of the hibernaculum. Additionally, excavation should never occur within the buffer area for any hibernacula, and heavy equipment should not be allowed on it. This could result in collapse of the important underground features. Additionally, topsoil should never be removed in this area because it could affect the depth to which frost penetrates, thereby reducing the effectiveness of the hibernaculum in protecting wintering snakes. Care needs be taken to avoid snow compaction above or in the vicinity of known hibernacula as this can reduce the insulation value of snow cover and permit deeper frost penetration.

When planning a road near a hibernacula, it is important to understand the movement patterns of the species that are using it. The road should be routed so that it does not intercept important movement corridors between critical habitat components.

Steps should be taken to control speed on roads in the vicinity of hibernacula. Signage and public education programs may help to prevent excessive road mortality and mortality at the hands of humans. At Long Point, however, signage has been ineffective in reducing road mortality and a small percentage of motorists deliberately run over snakes (Ashley et al. 2007). Speed humps could be installed in areas to control vehicle speeds.

In some cases, underpasses, culverts, or tunnels for snakes may be effective. Road underpasses for snakes have to be well designed in order to be effective. For the most part, snakes prefer to cross over the road because it will be warmer than going through a culvert or tunnel. Therefore, it may be necessary to create a barrier so that snakes cannot access the upper surface of the road.

Sufficient culverts should be installed under the road to ensure free movement of surface water and shallow groundwater.

There may also be opportunities to construct snake hibernacula, as described by the Ministry of Natural Resources (OMNR 2008b); however, the construction of snake hibernacula must always be a last resort to protection of natural hibernacula. When designing a hibernacula, several factors should be considered. In addition to the habitat requirements of the species in question, these include the water table depth, depth to bedrock, depth of frost penetration in winter, and whether the structure will be built above or under ground. Other considerations are the type and size of rocks or other material that will be used to construct the hibernaculum, the type of material used to cover it, whether or not it should be vegetated, and the type and orientation of entrance holes. Most designs have entrance holes that are far too large, and these are not attractive to snakes and the large entrance holes may result in cold air penetrating well into the hibernaculum and ingress by small mammalian predators. Entrances to natural snake hibernacula are typically inconspicuous and usually of very small diameter so that the snake has to squeeze to get inside.

If artificial hibernacula are being built, thought needs to be given to providing other key habitat features for the species in question. For snakes, these features could include hot rocks for basking and cover, brush piles for shedding and thermoregulation, and potential nesting sites. All of these should be provided within a small area to minimize the home range size of the snakes and therefore their exposure due to crossing roads and other areas that may increase the risk of mortality. Five-lined skinks have been shown to colonize and use experimental debris, at least during the active season, and to be tolerant to minor disturbances but not to removal or degradation of cover debris (Hecnar and M'Closkey 1998). Essential microhabitat features must be actively preserved as well as suitable habitat to ensure the conservation of this species.

INDEX #14: AMPHIBIAN BREEDING HABITAT (WOODLAND)

Ecoregions:	3E, 5E, 6E, 7E
Species Group:	Eastern (Red-spotted) Newt, Blue-spotted Salamander, Spotted Salamander, Gray Treefrog, Spring Peeper, Chorus Frog, Wood Frog, Four-toed Salamander, Eastern Red-backed Salamander, Northern Two-lined Salamander, American Toad
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Amphibian Breeding Habitat (Forested: Vernal Pools, Forested Wetlands, Seeps, Streams, Swamps)
Habitat Features:	Breeding pools (permanent, seasonal or ephemeral) within or adjacent to woodlands The Jefferson Salamander (THREATENED), Northern Dusky Salamander (ENDANGERED), Allegheny Mountain Dusky Salamander (ENDANGERED), and the Small-mouthed Salamander (ENDANGERED) are protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that may affect these species.

HABITAT DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Most amphibians require a source of water to reproduce. During spring, many of these species concentrate in woodland ponds to mate and lay eggs. Eggs are laid in water where they hatch as larvae. The larvae live in the water for varying lengths of time depending on the species, and eventually emerge as adults. The Eastern (Red-spotted) Newt is an exception in that the efts live on land for several years, returning to woodland ponds to live as the aquatic newt phase (Bishop 1943; Lamond 1994). Adults of other amphibian species either live in the pond or at its edge, disperse away from the pond once they emerge to live in terrestrial habitats some distance from the pond, returning in spring to breed or in autumn to hibernate in bottom sediments. Some other amphibians only return to ponds to breed and hibernate below the frost line in terrestrial habitats. Breeding ponds may be along the edge of swamps, in floodplains, in groundwater seeps, or in depressions in upland forests.

For a woodland pond to function as a breeding pond it requires the following elements:

1. Shallow, unpolluted water which may be permanent or temporary. If the water source is temporary it must hold water for a long enough time for larvae to develop into juveniles before the pond dries up.
2. Emergent and submergent vegetation may be used for calling sites and structure for egg laying. For some species, woody shrubs along the shoreline are valuable elements and other species prefer to attach their egg masses to branches and twigs in the water. Logs and other shoreline structures are important for some species for calling, resting, and providing escape cover from a variety of predators.
3. Surrounding woodland habitat of various compositions must provide a closed canopy offering a shaded, moist understory to retain breeding pond function. The forest understory should offer an abundance of downed woody debris to act as cover for amphibians while they are living in terrestrial habitats. It is very important that breeding ponds be close to summer habitat.

Timing of breeding, the length of time required for larvae to transform into juveniles, and specific habitat requirements differ among species. Many of these parameters are important in determining what breeding species of amphibians a pond can support.

See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

Development which results in the draining or filling of small woodland ponds will destroy the function of the pond and the surrounding land for amphibians. The loss of the breeding pond will affect the population dynamics of essentially all amphibian populations in the vicinity of the development.

Development on adjacent land can have significant impacts on breeding pond functions if it alters ground or surface water quality or quantity. Woodland ponds which dry up before larvae transform as a result of disruptions to hydrological function become unsuitable sites for reproduction. Adjacent development can have a very high impact if it separates breeding habitat from summer or winter habitat.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Tree cutting in the vicinity of the pond or development in terrestrial habitats used as summer range can affect amphibian habitat by changing the moisture regime of the woodland and destroying summer habitat for certain species. The impacts will be on breeding ponds and surrounding woodland used as summer habitat. Dry conditions greatly reduce the quality of woodland habitat for most amphibians. Reducing the amount of shade in the vicinity of the pond can result in premature drying of the pond, increased water temperatures and excessive growths of algae. The length of time the pond holds water in the spring is critical. Forest fragmentation as a result of development may reduce habitat for adults of certain species after they leave the breeding pond.

Dredging and clearing of shoreline vegetation and other in-pond structures (logs, stones, etc.) greatly reduces the quality of the pond as a breeding site. The loss of structure increases predation and affects amphibian populations within the pond and surrounding woodland.

Residential and commercial development may result in the release of contaminants (i.e., sediments, high nutrient concentrations, gasoline and oil, salt, etc.) in surface runoff, which may affect nearby breeding ponds owing to the sensitivity that amphibians show to aquatic toxicants. Excessive nutrients (e.g., from fertilizing lawns and gardens) will promote growth of algae in ponds. Although the presence of some algae aids in the oxygenation of pond water, algae blooms result in de-oxygenation.

Development may affect amphibian populations and hence the function of breeding ponds and summer range through human disturbance. Lot clearing, frog catching, and predation by pets can have considerable effects on some amphibian populations. These activities may impact breeding ponds even if development occurs on adjacent lands.

Other potential effects of development are road mortality of dispersing amphibians; noise pollution, which may interfere with spring breeding calls; spread of exotic species; and light pollution, which may potentially affect migration of food sources such as insect populations.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The habitat is the woodland and wetland ELC ecosites combined, including a connecting travel corridor.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, dredging and/or filling for development in amphibian breeding SWH will damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, site it along the edge of the habitat, and ensure that it doesn't change the quality or quantity of water in the breeding habitat.

The effects of development on breeding pond functions can be made less severe by ensuring that local water levels are not negatively affected or contaminated. This will require appropriate stormwater management and ensuring that groundwater recharge and discharge functions will not be altered by development in a manner which will affect the pond.

Steps need to be taken to ensure that forest cover remains intact around the pond allowing seasonal movement to and from the pond. There should never be removal of aquatic vegetation or other structures (logs, stones, etc.) from the pond or shoreline in an attempt to "clean it up". Simplifying the structural complexity of the pond may have significant impacts on its function as a breeding pond.

Total loss of an amphibian breeding pond identified as SWH would be unacceptable, however, if a proposed development would possibly have a negative effect on part of a pond or the adjacent habitat while maintaining the threshold levels for breeding adults as outlined in the SWHTG (OMNR 2000) there may be opportunity to create alternate breeding ponds in adjacent forest land if it is available and of suitable structure (i.e., relatively large woodlot, preferably connected to others, closed canopy, moist understory, with plenty of downed woody debris). Shallow dug ponds may begin functioning as breeding ponds relatively quickly provided they can be reached by amphibians dispersing from other areas. Populations of amphibians inhabiting the original breeding pond and surrounding habitat will be severely reduced by development activities. The amphibian community which establishes in the new pond may bear little resemblance to the original one (i.e., different number and species of amphibians). Gibbons et al. (2006) demonstrated that isolated ponds with a previous history of disturbance of the surrounding terrestrial habitat produced a very high biomass of amphibians once the surrounding area recovered from disturbance. Any type of compensatory work for amphibian breeding habitat should only be done as a last resort, where no other option exists.

Breeding ponds will not retain their function if suitable surrounding summer habitat is not maintained. Wetlands and other moist habitats must be preserved. For mole salamanders and other amphibians that spend their adult life in forest habitat, it is essential to maintain adequate forest cover. The forest must not be excessively fragmented so that it is too small to support the species initially inhabiting it. Salamander populations will also be adversely affected if logs and other ground structures are removed from the woodlot. In addition to their requirement for moist areas in the summer, mole salamanders need dry areas within the woodlot to spend the winter. Care is required to ensure that winter habitat is not destroyed by development.

A large area of natural habitat needs to be maintained near any development to ensure that all of the life history requirements of amphibians residing in the area are fulfilled. Migration corridors leading to/from the breeding area must be maintained. An Impact Assessment will need to address the amount of natural area that should be maintained or created.

For rural residential development on large lots, areas of forest and ephemeral and permanent ponds should be retained. Where possible, clustering development may leave a higher proportion of natural area.

Calhoun and Klemens (2002) summarized a subdivision design that was successful in protecting a population of salamanders. Houses were clustered several hundred feet from the vernal pool, and no more than 50% of lots were cleared which resulted in much of the site being protected in its natural state. Other mitigation measures were applied at this subdivision. Stormwater moves through a grassy swale and into an open, biofiltration wetland which minimizes mortality of salamanders and other wildlife caught in catch basins. Low gradient curbing was used to allow salamander movement. Additional restrictions at this subdivision regulated the design of individual driveways, the use of pesticides, herbicides, and salts, and exterior lighting.

Calhoun and Klemens (2002) also provided general guidelines for protecting amphibian habitat around vernal pools. They identified two zones around the vernal pool: the vernal pool envelope and the critical terrestrial habitat. The vernal pool envelope was defined as the area within 30 m of the pool's edge. Within this zone, they recommended that an undeveloped forested habitat is maintained around the pool, including both canopy and understory; that barriers to amphibian dispersal be avoided; that pool hydrology and water quality be maintained; and that this area be pesticide free. The critical terrestrial habitat was defined as that area within 30 to 228 m (750 ft) of the vernal pool (assuming that all of this area is forested). Calhoun and Klemens recommended maintaining or restoring 75% of this zone in contiguous forest with undisturbed canopy and understory; maintaining or restoring forested corridors that connect wetlands or vernal pools; maintaining at least a partially closed-canopy stand that will provide shade, litter, and woody debris; minimizing disturbance to the woodland floor; and maintaining native understory vegetation where possible.

Calhoun and Klemens (2002) also recommended that these guidelines be used as a planning tool, with the municipality completing inventories of vernal pools and assigning a priority for conservation targets. They recommended that conservation efforts be focused on:

1. ecologically significant pools along size and hydro period (length of time the pool holds water) gradients in order to protect a wide diversity of pool-breeding invertebrates and amphibians;

2. pools with intact critical terrestrial habitat;

3. pools with long-term conservation opportunities (e.g., pools on public land, not-for-profit lands, or in large tracts of relatively undisturbed private ownership); and

4. maintaining or restoring the adjacent terrestrial habitat for pools in agricultural or suburban/landscaped settings where the amount of forest cover is limited. (Although forest landscapes are preferred habitat, unfrequented agricultural lands support dispersal of many amphibians and have the potential to become even more valuable following old field succession or reforestation.)

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses are the type of major recreational development most likely to affect woodland amphibian breeding ponds, although ski resorts may also potentially affect amphibian breeding habitat.

Tree cutting in the vicinity of the pond or development in terrestrial habitats used as summer range can affect amphibian habitat by changing the moisture regime of the woodland. The impacts will be on breeding ponds and surrounding woodland used as summer habitat. Dry conditions greatly reduce the quality of woodland habitat for most amphibians. Reducing the amount of shade in the vicinity of the pond can result in premature drying of the pond and excessive growths of algae. The length of time the pond holds water in the spring is critical. Forest fragmentation as a result of development may reduce habitat for adults of certain species after they leave the breeding pond.

Dredging and clearing of shoreline vegetation and other in-pond structures (logs, stones, etc.) greatly reduces the quality of the pond as a breeding site. The loss of structure increases predation and affects amphibian populations within the pond and surrounding woodland.

Golf course development may result in the release of contaminants (i.e., sediments, high nutrient concentrations, fertilizers and pesticides, etc.) in surface runoff, which may affect nearby breeding ponds owing to the sensitivity that amphibians show to aquatic toxicants. Excessive nutrients (e.g., from fertilizing golf courses) will promote growth of algae in ponds. Although the presence of some algae aids in the oxygenation of pond water, algae blooms result in de-oxygenation.

Creation of fairways, tees, and greens may not only reduce adjacent upland habitat for amphibians, but they may inhibit movement between breeding and summer habitat.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The habitat is the woodland and wetland ELC ecosites combined, including a connecting travel corridor.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, dredging and/or filling for development in amphibian breeding SWH will damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, site it along the edge of the habitat, and ensure that it doesn't change the quality or quantity of water in the breeding habitat.

The effects of golf courses on breeding pond functions can be made less severe by ensuring that local water levels are not negatively affected or contaminated. This will require appropriate stormwater management and ensuring that groundwater recharge and discharge functions will not be altered in a manner which will affect the pond. The pond should not be used for irrigation purposes or for treating stormwater.

Grading of fairways, tees, and greens should be done so that water is does not flow directly into amphibian breeding ponds. Sufficient buffer areas need to be maintained around these features and the pond so that excessive nutrients and pesticides are taken up prior to discharge to the pond.

Steps need to be taken to ensure that forest cover remains intact around the pond allowing seasonal movement to and from the pond. There should never be removal of aquatic vegetation or other structures (logs, stones, etc.) from the pond or shoreline in an attempt to "clean it up". Simplifying the structural complexity of the pond and adjacent shoreline will most likely have significant impacts on its function as a breeding pond.

Total loss of an amphibian breeding pond identified as SWH to a golf course development would be unacceptable. However, if a proposed development would possibly have a negative effect on part of a pond or the adjacent habitat while maintaining the threshold levels for breeding adults as outlined in the SWHTG (OMNR 2000) there may be opportunity to create alternate breeding ponds in adjacent forest land if it is available and of suitable structure (i.e., relatively large woodlot, preferably connected to others, closed canopy, moist understory, with plenty of downed woody debris). Shallow dug ponds may begin functioning as breeding ponds relatively quickly provided they can be reached by amphibians dispersing from other areas. Populations of amphibians inhabiting the original breeding pond and surrounding habitat will be severely reduced by development activities. The amphibian community which establishes in the new pond may bear little resemblance to the original one (i.e., different number and species of amphibians).

Gibbons et al. (2006) demonstrated that isolated ponds with a previous history of disturbance of the surrounding terrestrial habitat produced a very high biomass of amphibians once the surrounding area recovered from disturbance. Boone et al. (2008) demonstrated that golf course ponds were effective in allowing American Toad and Spotted Salamanders to survive to metamorphosis, provided that the ponds did not support Bull Frogs. McDonough and Paton (2007) studied movements of radio-tracked Spotted Salamanders on a Connecticut golf course. They found that salamanders crossed fairways and that they were not a barrier to movement. Females moved farther than males. The authors suggested that protecting 164 m of upland habitat around the breeding pond would include 82% of adult males and 50% of females. To protect 95% of females, the core area around the pond would have to extend to 370 m.

Breeding ponds will not retain their function if suitable surrounding summer habitat is not maintained. Wetlands and other moist habitats must be preserved. For mole salamanders and other amphibians that spend their adult life in forest habitat, it is essential to maintain adequate forest cover. The forest must not be excessively fragmented so that it is too small to support the species initially inhabiting it. Salamander populations will also be adversely affected if logs and other ground structures are removed from the woodlot. In addition to their requirement for moist areas in the summer, mole salamanders need dry areas within the woodlot to spend the winter. Care is required to ensure that winter habitat is not destroyed by development.

Calhoun and Klemens (2002) provided general guidelines for protecting amphibian habitat around vernal pools. They identified two zones around the vernal pool: the vernal pool envelope and the critical terrestrial habitat. The vernal pool envelope was defined as the area within 30 m of the pool's edge. Within this zone, they recommended that an undeveloped forested habitat is maintained around the pool, including both canopy and understory; that barriers to amphibian dispersal be avoided; that pool hydrology and water quality be maintained; and that this area be pesticide free. The critical terrestrial habitat was defined as that area within 30 to 228 m (750 ft) of the vernal pool (assuming that all of this area is forested). Calhoun and Klemens recommended maintaining or restoring 75% of this zone in contiguous forest with undisturbed canopy and understory; maintaining or restoring forested corridors that connect wetlands or vernal pools; maintaining at least a partially closed-canopy stand that will provide shade, litter, and woody debris; minimizing disturbance to the woodland floor; and maintaining native understory vegetation where possible.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Amphibian breeding ponds and adjacent upland habitat may potentially be affected by all types of aggregate and mining development. Direct habitat loss may occur if the breeding pond is destroyed or if adjacent summer forest habitat is removed.

Indirect impacts may occur as a result of interrupting migration corridors; changing water-level regimes due to dewatering, pumping, and lowering of the water table; and changing water chemistry due to inputs of nutrients, sediments, and contaminants. These types of development may potentially bisect amphibian corridors between summer and breeding habitat.

In Nova Scotia, Mazerolle (2004) demonstrated that peat mining was detrimental to amphibian breeding populations and that numbers and species diversity of amphibians were much lower in mined bogs than natural bogs.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The habitat is the woodland and wetland ELC ecosites combined, including a connecting travel corridor.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and excavation for development in amphibian breeding SWH will damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, site it along the edge of the habitat, and ensure that it doesn't change the quality or quantity of water in the breeding habitat.

A suitable treed buffer around the breeding pond should also be retained. Calhoun and Klemens (2002) provided general guidelines for protecting amphibian habitat around vernal pools. They identified two zones around the vernal pool: the vernal pool envelope and the critical terrestrial habitat. The vernal pool envelope was defined as the area within 30 m of the pool's edge. Within this zone, they recommended that an undeveloped forested habitat is maintained around the pool, including both canopy and understory; that barriers to amphibian dispersal be avoided; that pool hydrology and water quality be maintained; and that this area be pesticide free. The critical terrestrial habitat was defined as that area within 30 to 228 m (750 ft) of the vernal pool (assuming that all of this area is forested). Calhoun and Klemens recommended maintaining or restoring 75% of this zone in contiguous forest with undisturbed canopy and understory; maintaining or restoring forested corridors that connect wetlands or vernal pools; maintaining at least a partially closed-canopy stand that will provide shade, litter, and woody debris; minimizing disturbance to the woodland floor; and maintaining native understory vegetation where possible.

Calhoun and Klemens (2002) also recommended that these guidelines be used as a planning tool, with the municipality completing inventories of vernal pools and assigning a priority for conservation targets. They recommended that conservation efforts be focused on:

1. ecologically significant pools along size and hydro period (length of time the pool holds water) gradients in order to protect a wide diversity of pool-breeding invertebrates and amphibians;

2. pools with intact critical terrestrial habitat;

3. pools with long-term conservation opportunities (e.g., pools on public land, not-for-profit lands, or in large tracts of relatively undisturbed private ownership); and
4. maintaining or restoring the adjacent terrestrial habitat for pools in agricultural or suburban/landscaped settings where the amount of forest cover is limited. (Although forest landscapes are preferred habitat, unfragmented agricultural lands support dispersal of many amphibians and have the potential to become even more valuable following old field succession or reforestation.)

If extraction will totally remove the pond there may be opportunity to create alternate breeding ponds in adjacent forest land if it is available and of suitable structure (i.e., relatively large woodlot, preferably connected to others, closed canopy, moist understory, with plenty of downed woody debris). Shallow dug ponds will begin functioning as breeding ponds relatively quickly provided they can be reached by amphibians dispersing from other areas. Populations of amphibians inhabiting the original breeding pond and surrounding habitat will be severely reduced by development activities. It is not safe to assume that they will simply move to the newly created site and take up residence there. The amphibian community which is established in the new pond may bear little resemblance to the original one (i.e., different number and species of amphibians). Gibbons et al. (2006) demonstrated that isolated ponds with a previous history of disturbance of the surrounding terrestrial habitat produced a very high biomass of amphibians once the surrounding area recovered from disturbance.

Even if the pond is to be retained with its original surrounding vegetation, there may be effects on the pond due to changes in hydrology. Hydro-geological and hydrological studies should be undertaken to determine if the hydro period of the pond will be affected by dewatering, lowering of the water table, or by pumping to dewater the work area. If water levels are likely to decline, they could be maintained by pumping. Water introduced into the pond for the purposes of maintaining water levels or for discharge of water from dewatering activities should be directed to a settling pond prior to entering the pond.

If extraction below the water table may result, it may be possible to install an impervious membrane around the proposed extraction area.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Land clearing within a woodland that contains amphibian breeding ponds represents a direct loss of habitat. Clearing of adjacent land can affect amphibian breeding habitat if it changes the moisture regime of the habitat. Dry conditions greatly reduce the quality of woodland habitat for most amphibians. Reducing the amount of shade in the vicinity of a breeding pond can result in premature drying of the pond and excessive growths of algae. The length of time the pond holds water in the spring is critical. Additionally, loss of forest cover near breeding ponds will reduce habitat for adults of certain species after they leave the breeding pond.

Dredging and clearing of shoreline vegetation and other in-pond structures (logs, stones, etc.) greatly reduces the quality of the pond as a breeding site. The loss of structure increases predation and affects amphibian populations within the pond and surrounding woodland.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of significant amphibian breeding habitat (woodland) should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The habitat is the woodland and wetland ELC ecosites combined, including a connecting travel corridor. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the breeding habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, dredging and/or filling for development in amphibian breeding SWH will damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, site it along the edge of the habitat, and ensure that it doesn't change the quality or quantity of water in the breeding habitat.

A suitable treed buffer around the breeding pond should also be retained. Calhoun and Klemens (2002) provided general guidelines for protecting amphibian habitat around vernal pools. They identified two zones around the vernal pool: the vernal pool envelope and the critical terrestrial habitat. The vernal pool envelope was defined as the area within 30 m of the pool's edge. Within this zone, they recommended that an undeveloped forested habitat is maintained around the pool, including both canopy and understory; that barriers to amphibian dispersal be avoided; that pool hydrology and water quality be maintained; and that this area be pesticide free. The critical terrestrial habitat was defined as that area within 30 to 228 m (750 ft) of the vernal pool (assuming that all of this area is forested). Calhoun and Klemens recommended maintaining or restoring 75% of this zone in contiguous forest with undisturbed canopy and understory; maintaining or restoring forested corridors that connect wetlands or vernal pools; maintaining at least a partially closed-canopy stand that will provide shade, litter, and woody debris; minimizing disturbance to the woodland floor; and maintaining native understory vegetation where possible.

Calhoun and Klemens (2002) also recommended that these guidelines be used as a planning tool, with the municipality completing inventories of vernal pools and assigning a priority for conservation targets. They recommended that conservation efforts be focused on:

1. ecologically significant pools along size and hydro period (length of time the pool holds water) gradients in order to protect a wide diversity of pool-breeding invertebrates and amphibians;

2. pools with intact critical terrestrial habitat;

3. pools with long-term conservation opportunities (e.g., pools on public land, not-for-profit lands, or in large tracts of relatively undisturbed private ownership); and

4. maintaining or restoring the adjacent terrestrial habitat for pools in agricultural or suburban/landscaped settings where the amount of forest cover is limited. (Although forest landscapes are preferred habitat, unfragmented agricultural lands support dispersal of many amphibians and have the potential to become even more valuable following old field succession or reforestation.)

Where land must be cleared either within or adjacent to the breeding habitat, ensure that it doesn't change the moisture regime of the remaining habitat. As much as possible, retain woodland habitat surrounding breeding ponds for the adults after they leave the breeding pond.

Potential Development Effects: Solar Power Facilities

Vegetation clearing in the vicinity of the pond or development in terrestrial habitats used as summer range can affect amphibian habitat by changing the moisture regime of the woodland and destroying summer habitat for certain species. The impacts will be on breeding ponds and surrounding woodland used as summer habitat. Dry conditions greatly reduce the quality of woodland habitat for most amphibians. Reducing the amount of shade in the vicinity of the pond can result in premature drying of the pond, increased water temperatures and excessive growths of algae. The length of time the pond holds water in the spring is critical. Forest fragmentation as a result of development may reduce habitat for adults of certain species after they leave the breeding pond.

Dredging and clearing of shoreline vegetation and other in-pond structures (logs, stones, etc.) greatly reduces the quality of the pond as a breeding site. The loss of structure increases predation and affects amphibian populations within the pond and surrounding woodland.

Construction may result in the release of contaminants (i.e., sediments, high nutrient concentrations, gasoline and oil, salt, etc.) in surface runoff, which may affect nearby breeding ponds owing to the sensitivity that amphibians show to aquatic toxicants.

Other potential effects of development are road mortality of dispersing amphibians; noise pollution, which may interfere with spring breeding calls; and invasion by exotic plant species.

Mitigation Options: Solar Power Facilities

The siting of solar panels within 120 m of significant amphibian breeding habitat (woodland) should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The habitat is the woodland and wetland ELC ecosites combined, including a connecting travel corridor. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the breeding habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, dredging and/or filling for development in amphibian breeding SWH will damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint as small as possible, site it along the edge of the habitat.

The effects of development on breeding pond functions can be made less severe by ensuring that local water levels are not negatively affected or contaminated. This will require appropriate stormwater management and ensuring that groundwater recharge and discharge functions will not be altered by development in a manner which will affect the pond.

Steps need to be taken to ensure that forest cover remains intact around the pond allowing seasonal movement to and from the pond. There should never be removal of aquatic vegetation or other structures (logs, stones, etc.) from the pond or shoreline in an attempt to "clean it up". Simplifying the structural complexity of the pond may have significant impacts on its function as a breeding pond.

Total loss of an amphibian breeding pond identified as SWH would be unacceptable. If, however, a proposed development is likely to have a negative effect on part of the breeding habitat, while maintaining the threshold levels for breeding adults as outlined in the SWHTG (OMNR 2000), there may be opportunity to create alternate breeding ponds in adjacent forest land if it is available and of suitable structure (i.e., relatively large woodlot, preferably connected to others, closed canopy, moist understory, with plenty of downed woody debris). Shallow dug ponds may begin functioning as breeding ponds relatively quickly provided they can be reached by amphibians dispersing from other areas. Populations of amphibians inhabiting the original breeding pond and surrounding habitat will be severely reduced by development activities. The amphibian community which establishes in the new pond may bear little resemblance to the original one (i.e., different number and species of amphibians). Gibbons et al. (2006) demonstrated that isolated ponds with a previous history of disturbance of the surrounding terrestrial habitat produced a very high biomass of amphibians once the surrounding area recovered from disturbance. Any type of compensatory work for amphibian breeding habitat should only be done as a last resort, where no other option exists.

Breeding ponds will not retain their function if suitable surrounding summer habitat is not maintained. Wetlands and other moist habitats must be preserved. For mole salamanders and other amphibians that spend their adult life in forest habitat, it is essential to maintain adequate forest cover. The forest must not be excessively fragmented so that it is too small to support the species initially inhabiting it. Salamander populations will also be adversely affected if logs and other ground structures are removed from the woodlot. In addition to their requirement for moist areas in the summer, mole salamanders need dry areas within the woodlot to spend the winter. Care is required to ensure that winter habitat is not destroyed by development.

A large area of natural habitat needs to be maintained near any development to ensure that all of the life history requirements of amphibians residing in the area are fulfilled. Migration corridors leading to/from the breeding area must be maintained. An Impact Assessment will need to address the amount of natural area that should be maintained or created.

Calhoun and Klemens (2002) provided general guidelines for protecting amphibian habitat around vernal pools. They identified two zones around the vernal pool: the vernal pool envelope and the critical terrestrial habitat. The vernal pool envelope was defined as the area within 30 m of the pool's edge. Within this zone, they recommended that an undeveloped forested habitat is maintained around the pool, including both canopy and understory; that barriers to amphibian dispersal be avoided; that pool hydrology and water quality be maintained; and that this area be pesticide free. The critical terrestrial habitat was defined as that area within 30 to 228 m (750 ft) of the vernal pool (assuming that all of this area is forested). Calhoun and Klemens recommended maintaining or restoring 75% of this zone in contiguous forest with undisturbed canopy and understory; maintaining or restoring forested corridors that connect wetlands or vernal pools; maintaining at least a partially closed-canopy stand that will provide shade, litter, and woody debris; minimizing disturbance to the woodland floor; and maintaining native understory vegetation where possible.

Calhoun and Klemens (2002) also recommended that these guidelines be used as a planning tool, with the municipality completing inventories of vernal pools and assigning a priority for conservation targets. They recommended that conservation efforts be focused on:

1. ecologically significant pools along size and hydro period (length of time the pool holds water) gradients in order to protect a wide diversity of pool-breeding invertebrates and amphibians;
2. pools with intact critical terrestrial habitat;
3. pools with long-term conservation opportunities (e.g., pools on public land, not-for-profit lands, or in large tracts of relatively undisturbed private ownership); and
4. maintaining or restoring the adjacent terrestrial habitat for pools in agricultural or suburban/landscaped settings where the amount of forest cover is limited. (Although forest landscapes are preferred habitat, unfrequented agricultural lands support dispersal of many amphibians and have the potential to become even more valuable following old field succession or reforestation.)

ROAD DEVELOPMENT

Potential Development Effects

Road construction can have considerable impact on amphibian populations. In addition to direct habitat destruction if a road is routed through amphibian breeding habitat, impacts associated with road construction can have negative impacts on adjacent or nearby breeding habitat. Sedimentation, for example, may reduce water levels of wetland areas, and may also change the composition of pond substrate. Similarly, nutrients applied when road banks and rights-of-way are re-vegetated or maintained may run off or leach into nearby ponds.

As adults move to and from breeding ponds, large numbers are often killed by vehicles. This can be devastating, particularly in the spring. During cool spring nights, frogs may be attracted to the warmer road surface. Juveniles are also at risk as they disperse away from breeding ponds.

Road salt, sediments, gasoline and oil, etc. in road surface runoff may affect nearby breeding ponds owing to the sensitivity that amphibians show to aquatic toxicants.

Traffic noise from major roads may interfere with amphibian breeding choruses.

Eigenbrod et al. (2008) studied the relationships among amphibian abundance, forest cover, and road traffic near Ottawa. They found that presence of amphibians was negatively correlated with presence of roads and that this negative relationship was stronger than the positive association that amphibians demonstrated with forest cover. Results were species specific. American Toad and Grey Treefrog showed stronger associations with traffic than forest cover; Wood Frog and Spring Peeper showed stronger associations with forest cover than traffic; while Green Frog showed similar associations between traffic and forest cover.

Ward et al. (2008) studied the impact of single-lane roads through forested habitat on the Two-lined Salamander. They found that this species was actually more abundant in areas crossed by roads and concluded that its may not be as affected by roads and road effects, such as sedimentation, loss of canopy cover, and increased pollution as other salamander species.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The habitat is the woodland and wetland ELC ecosites combined, including a connecting travel corridor.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, dredging and/or filling for development in amphibian breeding SWH will damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, site it along the edge of the habitat, and ensure that it doesn't change the quality or quantity of water in the breeding habitat.

Road systems should always be designed so that they do not run parallel to breeding ponds or cut off summer habitat from the breeding pond so that road mortality is minimized. In New York, Langen et al. (2007) found that amphibian mortality on highways was highest where there was wetland habitat on both sides of the road. Therefore, if breeding ponds cannot be avoided by roads, they need to be designed so that they are at the edge of the wetland to reduce road kill.

In some areas, it may be necessary to install culverts to allow amphibian movement underneath roads. Although this has been undertaken in a few areas in the province, limited study has been done on the efficacy of this mitigation technique. It does appear, however, that amphibians still prefer to travel over the road surface than through a culvert, therefore culverts should not be considered without some form of funnel fencing or wall to route amphibians to the culverts.

If culverts are considered necessary and feasible, it is important that an appropriate design is selected to ensure that maximum numbers of amphibians will use them. McCormack Rankin Corporation and Ecoplans Limited (2002) completed a detailed literature review on design guidelines for tunnels or culverts intended to provide passage for amphibians under roads. They concluded that box, circular, and elliptical shaped culverts were equally effective in allowing passage of amphibians, and that there appeared to be no difference whether the culverts were concrete or steel. In order for a culvert to be used, it is important that amphibians can see light through it. Therefore, the diameter of the culvert must increase with increasing length. If open grates are provided along the culvert to allow extra light penetration, it may be possible to reduce the diameter of the culvert. Amphibians are known to use culverts that are at least 40 m in length, and culverts of this length should be a minimum of 1 m in diameter. Moisture in the culvert is an important criterion. There should be enough moisture in the culvert during wet weather to result in a flow of water through the culvert, but without excessive ponding, flooding, or high water velocities. There should be no drainage patterns perpendicular to either mouth of the culvert that might direct amphibians away from the culvert. It is important that there is substrate in the culvert, and 15 cm of native soil should be placed in it to facilitate amphibian passage. The best designs incorporate a perpendicular wall or funnel fence at each end of the culvert that runs parallel to the road, or out from it on an angle. This needs to be designed such that it prevents amphibians from accessing the road surface and directs them into the culvert.

Holtz et al. (2008) examined road crossing structures for amphibians in New York and found that different species preferred different designs. They concluded, however, that tunnels larger than 0.5 m in diameter lined with soil or gravel and accompanied by 0.6-0.9 high funnel fencing would best facilitate road crossing for most amphibian species.

Additional information on wildlife crossing designs, including both underpasses and overpasses, is presented by Wildlife Crossings Info (2007).

INDEX #15: AMPHIBIAN BREEDING HABITAT (WETLAND)

Ecoregions:	3E, 5E, 6E, 7E
Species Group:	Eastern (Red-spotted) Newt, Blue-spotted Salamander, Spotted Salamander, Four-toed Salamander, American Toad, Gray Treefrog, Chorus Frog, Northern Leopard Frog, Pickerel Frog, Green Frog, Mink Frog, Bull Frog, Northern Two-lined Salamander
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Amphibian Breeding Habitat (Non-forested Wetlands)
Habitat Features:	Presence of shrubs and logs to provide structure for calling, foraging, escape, concealment Fowler's Toad (ENDANGERED), Jefferson Salamander (THREATENED) and the Small-mouthed Salamander (ENDANGERED) are protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that may affect these species.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Most amphibians require a source of water to reproduce. During spring, many of these species concentrate in breeding ponds to mate and lay eggs. Eggs are laid in water where they hatch as larvae. The larvae live in the water for varying lengths of time depending on the species, and eventually emerge as adults. The Eastern (Red-spotted) Newt is an exception in that the larvae live on land for several years, returning to woodland ponds to live as adults (Bishop 1943; Lamond 1994). Adults of other amphibian species either live in the pond or at its edge, disperse away from the pond once they emerge to live in terrestrial habitats some distance from the pond, returning in spring to breed or in autumn to hibernate in bottom sediments. Breeding ponds may be along the edge of swamps, in floodplains, in groundwater seeps, or in depressions in upland forests.

Timing of breeding, the length of time required for larvae to transform into adults, and specific habitat requirements differ among species. Many of these parameters are important in determining what breeding species of amphibians a pond or wetland can support.

See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

Large subdivisions and commercial developments have the greatest potential to affect the function of breeding ponds and wetlands and summer range simply because of the expansive areas involved and major changes that are made to the hydrological function of the area.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Excavation and drainage associated with development are usually undertaken to dry the site and direct surface water away from buildings, roads and other structures. Any permanent drying of soils within open meadows will disrupt the function of the area as summer range for frogs. Draining of meadows will affect Leopard Frogs and Pickerel Frogs in particular. The loss of the breeding pond will affect the population dynamics of essentially all amphibian populations in the vicinity of the development.

Lot-clearing activities are another source of impact on frog habitat. As wild grassland plant communities are mowed and replaced with manicured lawns, etc. their suitability as insect-producing areas is reduced. Cleared or mowed sites also tend to dry out more quickly than naturally-vegetated areas. The increased frog mortality rate associated with lawn cutting in rural areas should not be discounted as to its effect on local frog populations. Removal of downed woody debris reduces the availability of daytime resting sites for frogs and other species. The net effect of these activities is a drying of the area which results in its loss of function as summer habitat.

Development on adjacent land may affect summer frog habitat if changes to hydrological function occur. If any parts of the development prevent frogs from moving from the wetland to moist meadow habitat or prevent larvae from maturing due to earlier desiccation of ponds areas of summer range will become devoid of frogs. Increased traffic may result in increased mortality of frogs crossing roads.

Dredging and clearing or filling of shoreline vegetation and other in-pond structures (logs, stones, etc.) greatly reduces the quality of the wetland as a breeding site. The loss of structure increases predation and affects amphibian populations within the wetland and surrounding areas. As vegetation is removed mortality among larvae and adults is likely to increase. The degree of impact to amphibian populations will depend on how water levels and aquatic plants are affected. Water-level fluctuations may seriously affect Green Frog and Bull Frog populations owing to effects on floating egg masses during early summer and by leading to high over-winter mortality of hibernating frogs. Additionally, because of the long maturation time for Bull Frogs, increased mortality rates in a population can have significant impacts on reproduction and hence recruitment (a measure of the number of individuals added to the population).

Residential and commercial development may result in the release of contaminants (i.e., sediments, high nutrient concentrations, salt, gasoline and oil, etc.) in surface runoff, which may affect nearby breeding ponds owing to the sensitivity that amphibians show to aquatic toxicants. Contaminants may also bioaccumulate in amphibians leading to reduced population levels. Excessive nutrients (e.g., from fertilizing lawns and gardens) will promote growth of algae in ponds. Although the presence of some algae aids in the oxygenation of pond water, algae blooms result in de-oxygenation.

Tree cutting in the vicinity of the wetland or development in terrestrial habitats used as summer range can affect amphibian habitat by changing the moisture regime of the wetland. The impacts will be on breeding ponds and surrounding wetland used as summer habitat. Dry conditions greatly reduce the quality of wetland habitat for most amphibians. Reducing the amount of shade in the vicinity of the wetland can result in premature drying of the wetland, increased water temperatures, and excessive growths of algae. The length of time the wetland holds water in the spring is critical.

Development may affect amphibian populations and hence the function of breeding ponds and summer range through human disturbance. Lot clearing, frog catching, and predation by pets can have considerable effects on some amphibian populations. These activities may impact breeding wetlands even if development occurs on adjacent lands.

Woodford and Meyer (2003) studied the impact of lakeshore development on the abundance of the Green Frog. They found that adult Green Frog populations were significantly lower on lakes with varying degrees of shoreline house and cottage development than lakes with little or no development. Densities of houses and cottages alone did not directly explain the reduction, and amount of suitable habitat was the best predictor of abundance. They concluded that greater development densities significantly decreased breeding habitat quality, resulting in lower frog abundance.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The habitat is the ELC ecosite wetland area and the shoreline.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, dredging and/or filling for development in amphibian breeding SWH will damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, site it along the edge of the habitat, and ensure that it doesn't change the quality or quantity of water in the breeding habitat.

The effects of development on breeding pond functions can be made less severe by ensuring that local water levels are not negatively affected or contaminated. This will require appropriate stormwater management and ensuring that groundwater recharge and discharge functions will not be altered by development in a manner which will affect the pond.

Steps need to be taken to ensure that forest cover (where it exists) remains intact around the wetland allowing seasonal movement to and from the wetland. There should be no removal of aquatic vegetation or other structures (logs, stones, etc.) from the wetland or shoreline in an attempt to "clean it up". Simplifying the structural complexity of the wetland will most likely have significant impacts on its function as a breeding site.

If development will totally remove the wetlands there may be opportunity to create alternate breeding wetlands on adjacent open lands (if they are available and of suitable structure) by excavating depressions which will collect surface water. Populations of amphibians inhabiting the original breeding pond and surrounding habitat will be severely reduced by development activities, however shallow dug ponds and wetlands may begin functioning as breeding ponds relatively quickly provided they can be reached by amphibians dispersing from other areas. Such a dispersion pattern would make frogs vulnerable to predation. Proponents should demonstrate that newly constructed habitat is being used by amphibians. It is not safe to assume that they will simply move to the newly created site and take up residence there. The amphibian community which is established in the new wetland may bear little resemblance to the original one (i.e., different number and species of amphibians). Gibbons et al. (2006) demonstrated that isolated ponds with a previous history of disturbance of the surrounding terrestrial habitat produced a very high biomass of amphibians once the surrounding area recovered from disturbance.

Breeding wetlands will not retain their function if suitable surrounding summer habitat is not maintained; in fact, a large area of natural habitat needs to be maintained near any development to ensure that all of the life history requirements of amphibians residing in the area are fulfilled. Wetlands and other moist habitats must be preserved. Non-forested amphibian breeding areas must not be excessively fragmented so that they become too small to support the species initially inhabiting them. Salamander populations will also be adversely affected if logs and other ground structures are removed. If natural vegetation is allowed to grow wild on drainage ponds and a supply of downed woody debris is provided, these sites may be used by frogs during summer (provided there is a linking corridor to adjacent wetlands). Each wetland needs to have easily-accessible summer habitat. If existing summer habitat cannot be preserved then it may be possible to create new habitat. Habitat areas must be large enough to prevent the concentration of large numbers of frogs in small areas. An Impact Assessment should address the amount of natural area that should be maintained or created.

Stormwater and other drainage should not be discharged directly into water bodies supporting breeding amphibian populations, both in light of suspended sediment and because of potential contaminants.

It may not be possible to mitigate the effects of multi-lot or commercial development on frog summer habitat if large-scale changes to the area's moisture regime occur. If hydrological function can be retained to maintain areas of poorly-drained soils, then summer frog habitat could be protected provided that vegetation is unaffected and habitat corridors are left to link summer habitat to nearby wetlands.

For rural residential development on large lots, areas of non-forested wetland pools (whether ephemeral or permanent) should be retained. Where possible, clustering development may leave a higher proportion of natural area.

For waterfront developments, shoreline vegetation should be kept intact. Removal of aquatic vegetation should be discouraged as this may be important amphibian breeding habitat, and also fish habitat.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses are the only type of major recreational development that is likely to have effects on wetland habitats that provide breeding habitat for amphibians.

Construction of fairways, tees, and greens may either directly affect breeding habitat, or may affect summer habitat for amphibians. Any permanent drying of soils within open meadows or conversion of these areas to manicured grasses will disrupt the function of the area as summer range for frogs. Draining of meadows will affect leopard and pickerel frogs in particular. The loss of the breeding wetland will affect the population dynamics of essentially all amphibian populations in the vicinity of the development.

Golf course development on adjacent land may affect summer frog habitat if changes to hydrological function occur. If any parts of the development prevent frogs from moving from the wetland to moist meadow habitat or prevent larvae from maturing due to earlier desiccation of ponds, areas of summer range will become devoid of frogs.

Dredging and clearing or filling of shoreline vegetation and other in-pond structures (logs, stones, etc.) greatly reduces the quality of the pond as a breeding site. The loss of structure increases predation and affects amphibian populations within the pond and surrounding areas. As vegetation is removed mortality among larvae and adults is likely to increase. The degree of impact to amphibian populations will depend on how water levels and aquatic plants are affected.

Water-level fluctuations due to irrigation or other interferences with the natural hydrological cycle in breeding wetlands may seriously affect Green Frog and Bull Frog populations. These unnatural fluctuations have effects on floating egg masses during early summer and may lead to high over-winter mortality of hibernating frogs. Additionally, because of the long maturation time for Bull Frogs increased mortality rates in a population can have significant impacts on reproduction and hence recruitment.

Golf course development may result in the release of contaminants (i.e., sediments, high nutrient concentrations, herbicides, etc.) in surface runoff, which may affect nearby breeding wetlands owing to the sensitivity that amphibians show to aquatic toxicants. Contaminants may also bioaccumulate in amphibians leading to reduced population levels. Excessive nutrients (e.g., from fertilizing golf courses) will promote growth of algae in ponds. Although the presence of some algae aids in the oxygenation of pond water, algae blooms result in de-oxygenation.

Tree cutting in the vicinity of the pond or development in terrestrial habitats used as summer range can affect amphibian habitat by changing the moisture regime of the wetland. The impacts will be on breeding ponds and surrounding wetland used as summer habitat. Dry conditions greatly reduce the quality of wetland habitat for most amphibians. Reducing the amount of shade in the vicinity of the pond can result in premature drying of the wetland, increased temperatures and excessive growths of algae. The length of time the wetland holds water in the spring is critical.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The habitat is the ELC ecosite wetland area and the shoreline.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, dredging and/or filling for development in amphibian breeding SWH will damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, site it along the edge of the habitat, and ensure that it doesn't change the quality or quantity of water in the breeding habitat.

The effects of golf course development on breeding wetland functions can be made less severe by ensuring that local water levels are not negatively affected or contaminated. This will require appropriate stormwater management and ensuring that groundwater recharge and discharge functions will not be altered by development in a manner which will affect the pond.

Grading of fairways, tees, and greens should be done so that runoff from them does not flow directly into wetlands that are significant for breeding amphibians. Appropriate buffers around these playing areas and the wetland need to be maintained so that excessive sediments, nutrients, and contaminants are filtered out before water reaches the wetland.

Steps need to be taken to ensure that forest cover (where it exists) remains intact around the wetland allowing seasonal movement to and from the wetland. There should be no removal of aquatic vegetation or other structures (logs, stones, etc.) from the wetland or shoreline in an attempt to "clean it up". Simplifying the structural complexity of the wetland may have significant impacts on its function as a breeding site.

If development will totally remove the wetland there may be opportunity to create alternate breeding ponds or wetlands on adjacent open lands (if they are available and of suitable structure) by excavating depressions which will collect surface water. Populations of amphibians inhabiting the original breeding wetland and surrounding habitat will be severely reduced by development activities, however shallow dug wetlands and ponds may begin functioning as breeding sites relatively quickly provided they can be reached by amphibians dispersing from other areas. Such a dispersion pattern would make frogs vulnerable to predation. Proponents should demonstrate that newly constructed habitat is being used by amphibians. It is not safe to assume that they will simply move to the newly created site and take up residence there. The amphibian community which is established in the new wetland may bear little resemblance to the original one (i.e., different number and species of amphibians).

Gibbons et al. (2006) demonstrated that isolated ponds with a previous history of disturbance of the surrounding terrestrial habitat produced a very high biomass of amphibians once the surrounding area recovered from disturbance. Boone et al. (2008) demonstrated that golf course ponds were effective in allowing American Toad and Spotted Salamanders to survive to metamorphosis, provided that the ponds did not support Bullfrogs. Survival of amphibian larvae was greater in golf course ponds than natural ponds, possibly due to the relatively scarcity of predacious aquatic insects in golf course ponds.

McDonough and Paton (2007) studied movements of radio-tracked Spotted Salamanders on a Connecticut golf course. They found that salamanders crossed fairways and that they were not a barrier to movement. Females moved farther than males. The authors suggested that protecting 164 m of upland habitat around the breeding pond would include 82% of adult males and 50% of females. To protect 95% of females, the core area around the pond would have to extend to 370 m.

Breeding wetlands will not retain their function if suitable surrounding summer habitat is not maintained; in fact, a large area of natural habitat should always be maintained near any large-scale development to ensure that all of the life history requirements of amphibians residing in the area are fulfilled. Wetlands and other moist habitats must be preserved. Non-forested amphibian breeding areas must not be excessively fragmented so that they become too small to support the species initially inhabiting them. Salamander populations will also be adversely affected if logs and other ground structures are removed. If natural vegetation is allowed to grow wild on drainage ponds and a supply of downed woody debris is provided, these sites may be used by frogs during summer (provided there is a linking corridor to adjacent wetlands). Each wetland should have easily-accessible summer habitat. If existing summer habitat cannot be preserved then it may be possible to create new habitat. Habitat areas must be large enough to prevent the concentration of large numbers of frogs in small areas. An Impact Assessment should address the amount of natural area that should be maintained or created.

Stormwater and other drainage should not be discharged directly into water bodies supporting breeding amphibian populations, both in light of suspended sediment and because of potential contaminants.

Wetlands that are significant for breeding amphibians should not be used for irrigation purposes on golf courses. The fluctuating water levels may be detrimental to egg masses, particularly those that float on the water's surface or those that are attached to vegetation near the surface.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Amphibian breeding wetlands and adjacent upland habitat may potentially be affected by all types of aggregate and mining development. Direct habitat loss may occur if the breeding wetland is destroyed or if adjacent summer forest habitat is removed.

Indirect impacts may occur as a result of interrupting migration corridors; changing water-level regimes due to dewatering, pumping, and lowering of the water table; and changing water chemistry due to inputs of nutrients, sediments, and contaminants. These types of development may potentially bisect amphibian corridors between summer and breeding habitat.

In Nova Scotia, Mazerolle (2004) demonstrated that peat mining was detrimental to amphibian breeding populations and that numbers and species diversity of amphibians were much lower in mined bogs than natural bogs.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The habitat is the ELC ecosite wetland area and the shoreline.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and excavation for development in amphibian breeding SWH will damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, site it along the edge of the habitat, and ensure that it doesn't change the quality or quantity of water in the breeding habitat.

If extraction will totally remove the wetland there may be opportunity to create alternate breeding wetlands or ponds in adjacent forest land if it is available and of suitable structure (i.e., relatively large woodlot, preferably connected to others, closed canopy, moist understory, with plenty of downed woody debris). Shallow dug wetlands or ponds may begin functioning as breeding ponds relatively quickly provided they can be reached by amphibians dispersing from other areas. Populations of amphibians inhabiting the original breeding wetland and surrounding habitat will be severely reduced by development activities. It is not safe to assume that they will simply move to the newly created site and take up residence there. The amphibian community which is established in the new wetland may bear little resemblance to the original one (i.e., different number and species of amphibians). Gibbons et al. (2006) demonstrated that isolated ponds with a previous history of disturbance of the surrounding terrestrial habitat produced a very high biomass of amphibians once the surrounding area recovered from disturbance.

Even if the wetland is to be retained with its original surrounding vegetation, there may be effects on the wetland due to changes in hydrology. Hydro-geological and hydrological studies should be undertaken to determine if the hydro period of the wetland will be affected by dewatering, lowering of the water table, or by pumping to dewater the work area. If water levels are likely to decline, they could be maintained by pumping. Water introduced into the pond for the purposes of maintaining water levels or for discharge of water from dewatering activities should be directed to a settling pond prior to entering the pond.

If extraction below the water table may result, it may be possible to install an impervious membrane around the proposed extraction area to prevent lowering of the water table in the vicinity of the wetland.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Draining and filling of wetlands for construction of turbine pads would destroy amphibian breeding habitat.

Dredging and clearing of shoreline vegetation and other in-pond structures (logs, stones, etc.) greatly reduces the quality of the pond as a breeding site. The loss of structure increases predation and affects amphibian populations within the pond and surrounding wetland. As vegetation is removed mortality among larvae and adults is likely to increase. The degree of impact to amphibian populations will depend on how water levels and aquatic plants are affected. Water-level fluctuations may seriously affect Green Frog and Bull Frog populations owing to effects on floating egg masses during early summer and by leading to high over-winter mortality of hibernating frogs. Additionally, because of the long maturation time for Bull Frogs, increased mortality rates in a population can have significant impacts on reproduction and hence recruitment (a measure of the number of individuals added to the population).

Development on adjacent land may affect summer frog habitat if changes to hydrological function occur. If any parts of the development prevent frogs from moving from the wetland to moist meadow habitat or prevent larvae from maturing due to earlier desiccation of ponds areas of summer range will become devoid of frogs.

Tree cutting in the vicinity of the pond or development in wetland habitats used as summer range can affect amphibian habitat by changing the moisture regime. Dry conditions greatly reduce the quality of wetland habitat for most amphibians. The length of time the wetland holds water in the spring is critical.

Mitigation Options: Wind Power Facilities

No renewable energy project may be developed within or expanded into significant amphibian breeding habitat in a provincially significant southern or coastal wetland (O.Reg. 37.1 and 37.2). The siting of wind turbines within 120 m of significant amphibian breeding habitat (wetland) in a provincially significant northern wetland or elsewhere should be avoided. The habitat is the ELC ecosite wetland area and the shoreline. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, dredging and/or filling for development in amphibian breeding SWH will damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, site it along the edge of the habitat, and ensure that it doesn't change the quality or quantity of water in the breeding habitat.

As much as possible, retain shoreline vegetation and other in-pond structures (logs, stones, etc.) that serve as protection for amphibians from predators. Additionally, when vegetation is removed, mortality among larvae and adults will likely increase. The degree of impact to amphibian populations will depend on how water levels and aquatic plants are affected. Water-level fluctuations may seriously affect Green Frog and Bull Frog populations owing to effects on floating egg masses during early summer and by leading to high over-winter mortality of hibernating frogs. Additionally, because of the long maturation time for Bull Frogs, increased mortality rates in a population can have significant impacts on reproduction and hence recruitment (a measure of the number of individuals added to the population).

In some cases, it may be possible to expand the wetland. This type of mitigation should never be planned as a trade-off for destroying some of the original wetland. Proponents wishing to enhance wetland functions or size should refer to the Temperate Wetland Restoration Guidelines (Mansell et al. 1998).

Potential Development Effects: Solar Power Facilities

Vegetation clearing and the installation of solar panels in wetland amphibian breeding habitat will damage or destroy the habitat. By design, solar panels capture sunlight that would normally reach the habitat. A dramatic reduction in sunlight will have significant impacts on the underlying plant community, likely leading to the loss of biomass and structure. Cleared sites tend to dry out more quickly than naturally-vegetated areas. Removal of downed woody debris reduces the availability of daytime resting sites for frogs and other species. The net effect of these activities is a drying of the area which results in its loss of function as summer habitat.

Dredging and clearing or filling of shoreline vegetation and other in-pond structures (logs, stones, etc.) greatly reduces the quality of the wetland as a breeding site. The loss of structure increases predation and affects amphibian populations within the wetland and surrounding areas. As vegetation is removed mortality among larvae and adults is likely to increase. The degree of impact to amphibian populations will depend on how water levels and aquatic plants are affected. Water-level fluctuations may seriously affect Green Frog and Bull Frog populations owing to effects on floating egg masses during early summer and by leading to high over-winter mortality of hibernating frogs. Additionally, because of the long maturation time for Bull Frogs, increased mortality rates in a population can have significant impacts on reproduction and hence recruitment (a measure of the number of individuals added to the population).

Excavation and drainage associated with development are usually undertaken to dry the site and direct surface water away from structures and roads. Any permanent drying of soils within open meadows will disrupt the function of the area as summer range for frogs. Draining of meadows will affect Leopard Frogs and Pickerel Frogs in particular. The loss of the breeding pond will affect the population dynamics of essentially all amphibian populations in the vicinity of the development.

The construction of access roads in wetland amphibian breeding habitat will physically destroy the affected habitat. Roads also have the potential to affect the hydrology of the surrounding habitat with subsequent changes in vegetation.

Construction may result in the release of contaminants (i.e., sediments, high nutrient concentrations, gasoline and oil, salt, etc.) in surface runoff, which may affect nearby breeding ponds owing to the sensitivity that amphibians show to aquatic toxicants. Contaminants may also bioaccumulate in amphibians leading to reduced population levels.

Development on adjacent land may affect summer frog habitat if changes to hydrological function occur. If any parts of the development prevent frogs from moving from the wetland to moist meadow habitat or prevent larvae from maturing due to earlier desiccation of ponds areas of summer range will become devoid of frogs. Vegetation clearing on lands adjacent to the breeding wetland can affect amphibian habitat by changing the moisture regime of the breeding wetland. Dry conditions greatly reduce the quality of wetland habitat for most amphibians. Reducing the amount of shade in the vicinity of the wetland can result in premature drying of the wetland, increased water temperatures, and excessive growths of algae. The length of time the wetland holds water in the spring is critical.

Development-related human disturbance may affect amphibian populations and hence the function of breeding ponds and summer range.

Mitigation Options: Solar Power Facilities

No renewable energy project may be developed within or expanded into significant amphibian breeding habitat in a provincially significant southern or coastal wetland (O.Reg. 37.1 and 37.2). The siting of solar panel arrays within 120 m of significant amphibian breeding habitat (wetland) in a provincially significant northern wetland or elsewhere should be avoided. The habitat is the ELC ecosite wetland area and the shoreline. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, dredging and/or filling for development in amphibian breeding SWH will damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint as small as possible, site it along the edge of the habitat, and ensure that it doesn't change the quality or quantity of water in the breeding habitat.

The effects of development on breeding pond functions can be made less severe by ensuring that local water levels are not negatively affected or contaminated. This will require appropriate stormwater management and ensuring that groundwater recharge and discharge functions will not be altered by development in a manner which will affect the pond. Stormwater and other drainage should not be discharged directly into water bodies supporting breeding amphibian populations, both in light of suspended sediment and because of potential contaminants.

Steps need to be taken to ensure that forest cover (where it exists) remains intact around the wetland allowing seasonal movement to and from the wetland. As much as possible, retain shoreline vegetation and other in-pond structures (logs, stones, etc.) that serve as protection for amphibians from predators. Additionally, when vegetation is removed, mortality among larvae and adults will likely increase. The degree of impact to amphibian populations will depend on how water levels and aquatic plants are affected. Water-level fluctuations may seriously affect Green Frog and Bull Frog populations owing to effects on floating egg masses during early summer and by leading to high over-winter mortality of hibernating frogs. Additionally, because of the long maturation time for Bull Frogs, increased mortality rates in a population can have significant impacts on reproduction and hence recruitment (a measure of the number of individuals added to the population).

In some cases, it may be possible to expand the wetland. This type of mitigation should never be planned as a trade-off for destroying some of the original wetland. Proponents wishing to enhance wetland functions or size should refer to the Temperate Wetland Restoration Guidelines (Mansell et al. 1998).

Breeding wetlands will not retain their function if suitable surrounding summer habitat is not maintained; in fact, a large area of natural habitat needs to be maintained near any development to ensure that all of the life history requirements of amphibians residing in the area are fulfilled. Wetlands and other moist habitats must be preserved. Non-forested amphibian breeding areas must not be excessively fragmented so that they become too small to support the species initially inhabiting them. Salamander populations will also be adversely affected if logs and other ground structures are removed. If natural vegetation is allowed to grow wild on drainage ponds and a supply of downed woody debris is provided, these sites may be used by frogs during summer (provided there is a linking corridor to adjacent wetlands). Each wetland needs to have easily-accessible summer habitat. If existing summer habitat cannot be preserved then it may be possible to create new habitat. Habitat areas must be large enough to prevent the concentration of large numbers of frogs in small areas. An Impact Assessment should address the amount of natural area that should be maintained or created.

ROAD DEVELOPMENT

Potential Development Effects

Amphibians are not all affected by road development in the same way. The abundance of the Mink Frog, for example, is negatively related to road density, while Pickerel Frog abundance is not significantly affected by roads but shows significant positive association with adjacent forest cover (Findlay et al. 2001). Eigenbrod et al. (2008) studied the relationships among amphibian abundance, forest cover, and road traffic near Ottawa. They found that presence of amphibians was negatively correlated with presence of roads and that this negative relationship was stronger than the positive association that amphibians demonstrated with forest cover. Results were species specific. Northern Leopard Frog and Gray Treefrog showed stronger associations with traffic than forest cover; Green Frog showed similar associations between traffic and forest cover. Species-specific consideration should be taken into account when both identifying impacts and contemplating appropriate mitigative actions.

New highway and road corridors may traverse seasonally wet meadow areas, destroying summer habitat for amphibians. Even when habitat is not crossed, drainage of surrounding areas will affect the hydrology of seasonally wet areas. Sedimentation resulting from road construction may reduce water levels of wetland areas, and may also change the composition of wetland substrate. Similarly, nutrients applied when road banks and rights-of-way are re-vegetated may run off or leach into nearby ponds.

In New York, Langen et al. (2007) found that amphibian mortality on highways was highest where there was wetland habitat on both sides of the road. New roads that cross migration corridors between wintering and breeding areas will likely result in greater frog mortality. This can be devastating, particularly in the cool spring when frogs may be attracted to the warmer road surface. Juveniles are also at risk as they disperse away from breeding ponds.

Road surface runoff (e.g., sediments, road salt, oil and grease) can negatively affect water quality and the nature of pond substrate.

Roads can act as a barrier to surface water movement, thus affecting water levels in wetlands either side of the road. This in turn may affect the distribution and abundance of aquatic vegetation and the suitability of the area to support breeding amphibians.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The habitat is the ELC ecosite wetland area and the shoreline.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, dredging and/or filling for development in amphibian breeding SWH will damage or destroy the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, site it along the edge of the habitat, and ensure that it doesn't change the quality or quantity of water in the breeding habitat. Routing roads along the edge of the habitat will also help reduce road-related mortality.

In addition to mitigation actions listed in the other development categories, new roads and highways should be designed to maximize opportunities for frog migration (e.g., incorporation of culverts that are big enough for light penetration (i.e., 1 m diameter minimum) and of close enough proximity (50 m)). Lost moist field habitat should be replaced with similar constructed seasonal wetlands. Such replacement habitat should be located far enough away from the road so as to avoid potential road salt, sediment and contaminant impacts.

If crossing-culverts are considered necessary and feasible, it is important that an appropriate design is selected to ensure that maximum numbers of amphibians will use them. McCormack Rankin Corporation and Ecoplans Limited (2002) completed a detailed literature review on design guidelines for tunnels or culverts intended to provide passage for amphibians under roads. They concluded that box, circular, and elliptical shaped culverts were equally effective in allowing passage of amphibians, and that there appeared to be no difference whether the culverts were concrete or steel. In order for a culvert to be used, it is important that amphibians can see light through it. Therefore, the diameter of the culvert must increase with increasing length. If open grates are provided along the culvert to allow extra light penetration, it may be possible to reduce the diameter of the culvert. Amphibians are known to use culverts that are at least 40 m in length, and culverts of this length should be a minimum of 1 m in diameter. Moisture in the culvert is an important criterion. There should be enough moisture in the culvert during wet weather to result in a flow of water through the culvert, but without excessive ponding, flooding, and high water velocities. There should be no drainage patterns perpendicular to either mouth of the culvert that might direct amphibians away from the culvert. It is important that there is substrate in the culvert, and 15 cm of native soil should be placed in it to facilitate amphibian passage. The best designs incorporate a perpendicular wall at each end of the culvert that runs parallel to the road, or out from it on an angle. This needs to be designed such that it prevents amphibians from accessing the road surface and directs them into the culvert.

Holtz et al. (2008) examined road crossing structures for amphibians in New York and found that different species preferred different designs. They concluded, however, that tunnels larger than 0.5 m in diameter lined with soil or gravel and accompanied by 0.6-0.9 high fencing would best facilitate road crossing for most amphibian species. The Green Frog preferred tunnels with the greatest light permeability.

Additional information on wildlife crossing designs, including both underpasses and overpasses, is presented by Wildlife Crossings Info (2007).

For roads that pass through a marsh that supports significant breeding amphibian populations, culverts should be installed to allow water-level stabilization between the two halves of the wetland. Oversize box culverts should be installed in shallower areas that support emergent vegetation and this may allow movement of amphibians under the road. In some cases, a raised road may be preferable to a causeway type road. These types of roads, however, are significantly more expensive than causeways and it may be less expensive to change the route of the road to avoid the wetland or only infringe on the edge of it.

Even for roads that are not directly in the wetland, sufficient culverts should be installed to allow for the normal passage of water to the wetland.

Depending on the nature of the wetland and its sensitivity, runoff from the road should not be allowed to run directly into the wetland. Stormwater detention areas should be installed to intercept water and allow it to settle prior to discharge to the wetland. For roads within or immediately adjacent to the wetland, thought should be given to installing splash guards along the edge of the road. These are Plexiglas barriers that attach to the railings and help reduce salt spray and introduction of other contaminants. If these types of barriers are planned, there should be adequate room under the road to allow wildlife movement from one side of the marsh to the other.

In southeastern Ontario, significant conservation gains can be achieved through local land-use planning and management decisions that mitigate the effects of existing roads, minimize the construction of new roads, and discourage further land conversion on lands adjacent to wetlands (Findlay et al. 2001).

INDEX #16: BUTTERFLY MIGRATORY ROUTE/STOPOVER AREAS

Ecoregions:	6E, 7E
Species Group:	Monarch (SPECIAL CONCERN), Painted Lady, Red Admiral
Significant Wildlife Habitat Category:	Seasonal Concentration Areas
Functional Habitat:	Migratory Route/Stopover Areas
Habitat Features:	Combination of field and forest (> 10 ha) located within 5 km of Lake Ontario and Lake Erie

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

Habitat Function and Composition

Open water shorelines on large lakes, especially the Great Lakes, provide natural migratory routes and staging areas for migrating butterflies. Crossing large open bodies of water is hazardous for butterflies. They need places to rest before and after crossing the Great Lakes.

The Monarch butterfly is the most regular migratory butterfly in Ontario. Adults migrate southward in autumn, congregating in large numbers along the northern shoreline of the Great Lakes, particularly Lake Erie. The adults overwinter predominantly in Mexico, and then return in the spring to breed (Crolla and Fontaine 1997).

The Painted Lady is probably the most cosmopolitan of all butterflies. In Canada, it is found from coast to coast, although not typically in large numbers (Layberry et al. 1998). The species appears in the south in May, followed by locally emerging specimens that can be observed from June through October (Layberry et al. 1998). The Painted Lady is often found in sandy areas (Gallant 1999), but is quite tolerant of different habitats (Layberry et al. 1998). It is commonly a butterfly of open areas, including roadsides, old fields, vacant lots, gardens and anywhere thistles abound (Layberry et al. 1998).

The White Admiral is usually a common and sometimes abundant species in most of its range. Adults fly from June to August, with a partial second generation into September (Layberry et al. 1998). White Admirals inhabit deciduous and mixed forests, using edge habitats and forest clearings; the species also uses roads (Layberry et al. 1998; University of Michigan 2008b).

Numerous other butterfly species wander northward from the United States in summer. Some species do this regularly, while others are sporadic visitors. All of these species benefit from having resting places and food resources along the shorelines of the lower Great Lakes. Other examples of species that may cross the Great Lakes are checkered skipper, fiery skipper, pipe vine swallowtail, checkered white, little sulphur, snout butterfly, variegated fritillary, painted lady, and the buckeye. These migrants from the south often establish breeding populations in the province that persist a few years after major incursions (Holmes et al. 1991).

The structure and composition of habitats distributed along shoreline migration routes and particularly in traditional migration stopover areas are important to the maintenance of the area's migration function. A diversity of habitat types ranging from open grasslands to forests is required. Most of the butterfly species that migrate prefer open habitats such as meadows, as these support food plant species for most of them (Holmes et al. 1991). The monarch butterfly frequently rests in large numbers on trees, so the presence of shrubs and trees is important to it and some other butterfly species (Crolla and Fontaine 1997).

Geography may dictate the use of shoreline areas used as migration stopover areas more strongly than habitat structure and composition. Land forms and width of the adjacent lake may be important in defining butterfly staging areas. Ideally, migration stopover areas should offer large areas of a variety of undisturbed habitat types.

Old-field area and weedy fields are important to some butterfly species. The monarch commonly feeds on the nectar of asters, goldenrods, and a variety of wild flowers that typically grow in meadows (Crolla and Fontaine 1997). Adult Painted Lady butterflies eat the nectar from plants one to two metres high, especially thistles. The species also uses aster, cosmos, blazing star, ironweed and joe-pye weed. Other frequented flowers include red clover, buttonbush, privet and milkweeds (Earth Day Canada n.d.).

Most of the other migratory butterflies are also associated with open areas and feed on plant species such as mustards, grasses, mallows, violets, may-apple, pansies, purslane, and several species within the aster family (Holmes et al. 1991). An exception is the White Admiral, which uses wild cherry, poplar, aspens, and black oaks as foodplants (University of Michigan 2008b).

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Multi-lot developments (residential and cottage) in proximity to shoreline migratory/stopover areas have the potential to reduce or possibly eliminate the function of an area as a migration route or stopover area owing to the relatively large areas impacted.

Tree cutting and other lot-clearing and modification activities which reduce the density of foliage and simplify forest structure may affect the quality of the area for migrating butterflies. Even more important to butterflies is the continued existence of old-field habitats. Conversion of old fields to residential development and/or manicured cover (e.g., lawns around houses and cottages) will greatly reduce or eliminate the function of the area as a butterfly concentration site.

Development on adjacent land is not expected to affect the function of migration stopover areas.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The habitat needs to be at least 10 ha in size, with a combination of field and forest present, and located within 5 km of Lake Ontario or Erie to be SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in butterfly migratory stopover SWH will physically destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible and site it along the edge of the habitat where butterfly activity is lowest.

Leave undisturbed as much forest and open habitat (e.g., old fields, meadows) as possible. If lot-clearing activities are extensive within areas used by butterflies as migration stopover areas, then mitigation may not be possible. Post-construction mitigation can include restoring the "naturalness" of vegetation by establishing areas of herbaceous plants, shrubs, and trees. Planting patches of wildflowers will be attractive to migrating butterflies (e.g., monarchs need milkweed as a larval host and wildflowers in general for nectar). Once developments mature, flower gardens may provide some habitat for migrating butterflies, especially when planted with species preferred by butterflies as larval hosts or for food (e.g., milkweed, wild lupines, butterfly weed, joe-pye weed, liatris, asters, etc.).

Habitat around affected traditional migration stopover sites can also be enhanced by naturalizing nearby roadsides and other rights-of-way (e.g., utilities). In the case of new roads, rights-of-way should be seeded with wildflowers, and mowing should be avoided until after autumn migration.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses and marinas are the types of major recreational development that have the potential to affect butterfly migration areas.

Replacement of old-field habitat with manicured turf grass for golf course fairways, tees, and greens will result in the loss of butterfly stopover habitat. Cutting swathes in forested areas for these facilities may also result in habitat loss. Spraying of herbicides and pesticides on golf courses may kill plant species that are used by migrating butterflies.

Recreational developments in proximity to shoreline migratory/stopover areas have the potential to reduce or possibly eliminate the function of an area as a migration route or stopover area owing to the relatively large areas impacted.

Development on adjacent land is not expected to affect the function of migration stopover areas.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The habitat needs to be at least 10 ha in size, with a combination of field and forest present, and located within 5 km of Lake Ontario or Erie to be SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in butterfly migratory stopover SWH will physically destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible and site it along the edge of the habitat where butterfly activity is lowest. Leave undisturbed as much forest and open habitat (e.g., old fields, meadows) as possible.

On golf courses, there may be significant opportunities to improve habitat for migrating butterflies. Areas that are not being used for active play could be planted to native wildflowers that will be attractive to butterflies. Areas important to butterflies need to be maintained and not sprayed with herbicides unless the intention is to benefit butterfly habitat.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

There is the potential for development of pits and quarries in butterfly staging habitat. The excavated area would result in at least a temporary loss of habitat.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The habitat needs to be at least 10 ha in size, with a combination of field and forest present, and located within 5 km of Lake Ontario or Erie to be SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and excavation for development in butterfly migratory stopover SWH will physically destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible and site it along the edge of the habitat where butterfly activity is lowest. Leave undisturbed as much forest and open habitat (e.g., old fields, meadows) as possible.

During pit or quarry operations, there are opportunities to create habitat for migrating butterflies. Berms and other areas that are not part of the active operations should be planted to a suitable wildflower mix that will attract migrating butterflies.

When these areas are rehabilitated, the ultimate design is one that enhances habitat for migrating butterflies. This will include a mix of wildflower species as well as scattered shrubs and trees.

ENERGY DEVELOPMENT

Potential Development Effects: Biofuel Farms

The ploughing and subsequent conversion of natural grasslands, meadows and fallow fields to farmland to grow crops for ethanol production (e.g., biomass feedstock such as corn and soy) will destroy critical butterfly food habitat.

Mitigation Options: Biofuel Farms

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The habitat needs to be at least 10 ha in size, with a combination of field and forest present, and located within 5 km of Lake Ontario or Erie to be SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in butterfly migratory stopover SWH will physically destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. Where complete avoidance is not possible, leave undisturbed as much forest and open habitat (e.g., old fields, meadows) as possible. This may include fencerows, corners of fields that are difficult to harvest, and any areas that are marginal for production of biofuel crops.

Potential Development Effects: Wind Power Facilities

Habitat loss is an important potential impact of wind power development on butterflies. Butterflies are quite habitat specific, and can show strong responses to changes in vegetation (Grealey and Stephenson 2007). Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Clearing the woodland portion of butterfly stopover habitat would effectively destroy the habitat. Development of permanent access roads and pads for turbines would also destroy habitat.

Wind power facilities in or adjacent to butterfly migratory routes could also interfere with butterfly use of those routes, thereby reducing their ecological function. Grealey and Stephenson (2007) found no literature on how wind turbulence from turbines affects insect behaviour, but they speculated that butterflies could be repelled by the wake of the downwind vortex. Wind currents created by turbine blades may be great enough to sweep butterflies away from the rotating blades.

Although limited data are available, turbine blades do not appear to result in significant mortality to flying butterflies (Grealey and Stephenson 2007).

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of significant butterfly migratory stopover habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The habitat needs to be at least 10 ha in size, with a combination of field and forest present, and located within 5 km of Lake Ontario or Erie to be SWH. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in butterfly migratory stopover SWH will physically destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible and site it along the edge of the habitat where butterfly activity is lowest. Leave undisturbed as much forest and open habitat (e.g., old fields, meadows) as possible.

It may be possible to mitigate the potential impacts by planting wildflowers in areas adjacent to the staging habitat to create additional suitable staging habitat.

Potential Development Effects: Solar Power Facilities

Large-scale vegetation clearing in stopover habitat for butterflies will damage or destroy the affected habitat. Where clearing and installation occur in the forested portion of the habitat, loss of foliage and structure will degrade the quality of the site. Where clearing and installation occur in the old-field portion of the habitat, the underlying plant community will likely be significantly altered. By design, solar panels capture sunlight that would normally reach the habitat. A dramatic reduction in sunlight will have significant impacts on the underlying plant community, likely leading to the loss of biomass and structure.

Development on adjacent land is not expected to affect the function of butterfly stopover habitat.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of significant butterfly migratory stopover habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The habitat needs to be at least 10 ha in size, with a combination of field and forest present, and located within 5 km of Lake Ontario or Erie to be SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in butterfly migratory stopover SWH will damage or destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible and site it along the edge where butterfly activity is lowest.

Leave undisturbed as much forest and open habitat (e.g., old fields, meadows) as possible. If vegetation clearing is extensive within areas used by butterflies as migration stopover areas, then mitigation may not be possible. Post-construction mitigation can include restoring the "naturalness" of vegetation by establishing areas of herbaceous plants, shrubs, and trees. Planting patches of wildflowers will be attractive to migrating butterflies (e.g., monarchs need milkweed as a larval host and wildflowers in general for nectar).

Habitat around affected traditional migration stopover sites can also be enhanced by naturalizing nearby roadsides and other rights-of-way (e.g., utilities). In the case of new roads, rights-of-way should be seeded with wildflowers, and mowing should be avoided until after autumn migration.

ROAD DEVELOPMENT

Potential Development Effects

If road construction is planned through open areas where wildflowers grow and/or through forested areas, migratory route/stopover habitat may be lost. If similar areas are available in proximity to shoreline stopping areas, such impacts may be minimal as alternative feeding and roosting areas will be available to butterflies.

If the road will support high traffic levels and if vehicles will be travelling at high speeds, there is potential for direct mortality of migrating butterflies.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The habitat needs to be at least 10 ha in size, with a combination of field and forest present, and located within 5 km of Lake Ontario or Erie to be SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, excavation and/or filling for development in butterfly migratory stopover SWH will physically destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible and site it along the edge of the habitat where butterfly activity is lowest. Leave undisturbed as much forest and open habitat (e.g., old fields, meadows) as possible.

Habitat around affected traditional migration stopover sites can be enhanced by naturalizing roadsides and other rights-of-way (e.g., utilities). In the case of new roads, rights-of-way should be seeded with wildflowers, and mowing should be avoided until after autumn migration. This should only be done along roads that will have low to moderate traffic volumes and where the speed travelled will be relatively low. High-speed, high-traffic roads should always be routed away from significant butterfly concentrations if possible. If this is not possible, it may be better to make the roadsides along these roads less attractive to butterflies to minimize local concentrations and the potential for mortality due to collisions with vehicles.

Wherever possible, herbicide use should be avoided along migratory/stopover habitat. If herbicide use is necessary to encourage nectar-producing plants, application should be done in the autumn.

RARE
VEGETATION COMMUNITIES

INDEX #17: ALVAR

Ecoregions:	5E, 6E, 7E
Species Group:	Alvar
Significant Wildlife Habitat Category:	Rare Vegetation Community
Functional Habitat:	Preferred Habitat
Habitat Features:	Level unfractured or partially fractured limestone, a patchy mosaic of bare rock pavement, or shallow substrate over limestone bedrock (> 0.5 ha in size); vegetation cover varies from patchy to barren, with < 60% tree cover The Loggerhead Shrike (ENDANGERED) is strongly associated with alvar communities. It is protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that may affect this species.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Alvars are naturally open areas of thin soil over essentially flat limestone, dolostone, or marble bedrock. In spring, alvars may have standing water while in summer the soils may become very hot and dry. Alvar vegetation is adapted to these extreme variations in temperature and moisture (OMNR 2000). It should be noted that vegetation communities on bare rock or rock with thin soils on the Canadian Shield are typically on granitic rock, and these communities are considered rock barrens and not alvars.

Three general types of alvars are recognized in Ontario by the Natural Heritage Information Centre (NHIC) (2007) and in the Ecological Land Classification (ELC) for southern Ontario (Lee et al. 1998). These include open alvars, shrubland alvars, and treed alvars.

Open alvars tend to be predominantly rock pavement sparsely vegetated with specialized shrubs, grasses, sedges, and herbs. Dominant indicator species include shrubby cinquefoil, creeping juniper, scirpus-like sedge, Philadelphia panic grass, false pennyroyal, northern dropseed, little bluestem, tufted hairgrass, poverty grass, Canada bluegrass, and nodding onion (which occurs only at Stone Road alvar) (Lee et al. 1998; NHIC 2007).

Shrub alvars have 25% or greater coverage by shrubs such as common juniper, creeping juniper, shrubby cinquefoil, and fragrant sumac (Lee et al. 1998; NHIC 2007). These types of alvar may also support stunted specimens of trees such as white spruce and white cedar and they may also support many of the species that are found in open alvars.

Treed alvars support species such as chinquapin oak, shagbark hickory, prickly ash, white cedar, jack pine, white spruce, and red cedar, as well as shrubs, grasses, sedges, and forbs that may be found in open and shrub alvars (Lee et al. 1998; NHIC 2007).

Within a given area, there may be a variety of alvar types and gradation among the types due to small variations in soil depth and moisture regime. Therefore, there may be some areas of alvar that are somewhat intermediate between descriptions of alvar types in the ELC or the NHIC descriptions of communities. It is also important to recognize that the ELC manual does not cover Manitoulin Island, which supports large areas of highly significant alvar communities. Those alvar communities on Manitoulin Island may be best described using the vegetation communities listed by NHIC, although some of them are similar to the communities described in the ELC.

All alvar types in Ontario are provincially and globally significant (Bakowsky 1996). Fifty-four species of native vascular plants are known to have the majority of their occurrence in Ontario on alvars (Catling 1995). In that alvars are unique combinations of geological and soil conditions, many of the plant species that they support have a high Co-efficient of Conservatism and are of provincial significance. Catling and Brownell (1995) described the alvars within the Great Lakes region, where alvars are concentrated on the Bruce Peninsula, Manitoulin Island, the Lake Erie islands, the Carden Plain, the Napanee Plain, and the Smith Falls Plain.

Wildlife species associated with alvar habitats include the milksnake, Olympia marble butterfly, tawny crescent butterfly, Melanoplus mancus (locust), striped camel cricket, prairie meadow katydid, Eastern Towhee, Sharp-tailed Grouse, Upland Sandpiper, Grasshopper Sparrow, Clay-colored Sparrow, Vesper Sparrow, Horned Lark, Eastern Bluebird, Golden-winged Warbler, Northern Harrier, Red-headed Woodpecker and Sedge Wren (The Couchiching Conservancy 2005). Many of these species prefer grazed alvars over ungrazed alvars.

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Generally, alvars are not very favourable for housing or commercial development due to the difficulty in providing water and sewer services in areas with minimal soils. Nonetheless, they are often identified as good areas for parking lots adjacent to commercial development. Alvars converted to parking lots will be destroyed.

Most development on true alvars is single lot residential. Even these may have significant impacts on alvar communities if development occurs directly on the alvar. Typically, individual lots have topsoil added to them to provide suitable septic system substrates and so that a lawn may be planted. Any alvar habitat that is developed will probably be directly destroyed due to a combination of the footprint of the buildings and addition of topsoil to some or all of the remainder of the lot.

Development on adjacent lands has the potential to affect neighbouring alvar communities. Grading of the lot may result in changes in drainage patterns to the alvar, and this may interrupt the typical moisture regime of the alvar, i.e., wet in spring and very dry in summer. This in turn may affect the plant species growing on the alvar. Those with a high Coefficient of Conservatism are most likely to be affected, as these species are specifically adapted to the shallow soils and the moisture regime that is typically associated with them.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). An alvar site must be >0.5 ha in size to be SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Avoidance of high-quality alvar habitat by development is the best mitigation option. If the alvar is large enough, development may be possible at an edge or in areas of lower quality habitat (if these exist) as determined by an alvar expert. In large alvars, it may be possible to site the development at an edge where the amount of undisturbed alvar is maximized. Alternatively, there may be areas of poorer quality habitat (e.g., soils that are deeper than usual, or where there has been proliferation of species that are atypical of alvar habitat) within a large alvar; these could be developed as long as more than 0.5 ha of high quality alvar remains undisturbed. In either case, the footprint of the development should be minimized. Any development should also include provisions for protecting the undeveloped portion of the alvar during construction and after completion (e.g., fencing and/or signage to keep vehicles and people off the habitat).

Drainage from the development should always be directed away from the alvar to maintain the wet-drought cycle upon which alvar-dependent plant species depend.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

There is potential for alvars to be used for golf courses, although this potential is relatively small due to the thin layer of soil that is present and the flatness of alvars. Development of a golf course on an alvar will probably require importation of significant amounts of topsoil to allow appropriate growth of standard golf-course grasses and to provide topographical relief.

Development of a golf course on an alvar is likely to have significant and probably irreversible negative effects. Addition of more soil and grading to make fairways, tees, and greens will destroy the existing alvar vegetation. The irrigation and fertilization that is typically required on golf courses also has the potential to affect the moisture and nutrient regime on any retained, adjacent alvar habitat.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). An alvar site must be >0.5 ha in size to be SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Avoidance of high-quality alvar habitat by major recreational development is the best mitigation option. If an alvar or portion of it is proposed for development into a golf course, the highest quality portions of the alvar should always be retained. Development should be restricted to areas of the alvar that are of lower quality as determined by an alvar expert, such as those areas with deeper soils that may eventually evolve into another habitat type, areas with a high proportion of non-native plant species or with few plant species that are alvar obligates, or areas where the water cycle has already been affected by previous disturbances so that continued existence of alvar habitat is unlikely.

If areas of alvar will be retained, these areas need to be protected by fencing prior to and throughout construction to prevent equipment from accessing the alvar. No soil should be placed within the retained alvar. The water balance within the alvar should be maintained. This means that the same surface water catchment area should exist before and after construction and that the amount of water directed towards the alvar should not be artificially increased or decreased. A hydro-geological survey should be completed to fully understand the groundwater regime that is supporting the alvar, and the same regime should be mimicked after development. No increase in surface or ground water nutrients should occur as a result of the golf course and there should never be inputs of pesticides or other chemicals to the alvar.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Alvar communities are most at risk from aggregate extraction activities. Areas that are shallow to bedrock present the best opportunities for aggregate extraction. Certain of the alvars, such as on the Flamborough Plain and Carden Plain, have high quality aggregates that are required for building heavy-traffic highways. In many cases, both the aggregate resources and the alvar communities are of provincial significance.

Aggregate extraction in an alvar results in direct removal of the alvar community. Aggregate development on adjacent lands also has the potential to alter alvar communities. Direct loss may occur if berms for visual and noise barriers are constructed on top of alvar habitat. Alvar habitat may also be affected if water from the quarry is pumped into it or a pond is created on it, or if the surface water regime is otherwise affected by quarry activities. In that the water regime of most alvars is surface water driven, quarry dewatering activities are unlikely to have impacts on adjacent alvar habitats, but this should be studied during the hydro-geological investigations undertaken in support of the quarry.

Dust may also potentially be an adverse effect on adjacent alvar communities.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). An alvar site must be >0.5 ha in size to be SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Quarries in alvar communities will result in the loss of the portion of the alvar that is extracted. Avoidance of high-quality alvar habitat by development is the best mitigation option. Where complete avoidance is not possible, it may be possible to restore the depleted quarry to alvar if all extraction is completed above the water table. If extraction continues below the water table, the rehabilitated quarry will probably take the form of a lake with limited opportunity to restore alvar habitat. Examples exist in Ontario of alvar ecosystems in abandoned pit and quarry sites (Browning and Tan 2002).

Tomlinson et al. (2008) compared the biophysical properties of natural alvars to abandoned limestone quarry floors and found that they were very similar. Quarry floors supported a few less vascular plant species than natural alvars and more non-native plant species, but also supported 5 alvar endemics and 24 plant species characteristic of alvars. This demonstrates that quarry floors may evolve into alvars if left alone, while standard rehabilitation of quarries may inhibit or prevent alvars from developing. Stark et al. (2004) stated that restoration of alvar communities should begin by amending the site with sand enriched with organic matter.

It may be possible to create alvar habitat in areas that currently have deeper soils. By removing most of the soils, it may be possible to create conditions that are suitable for establishment of alvar communities. In some instances, removal of topsoil in preparation for extraction has resulted in alvar species becoming established on their own when extraction was delayed, particularly if adjacent alvar provides a seed source. If creation of new alvar habitat is considered as a mitigation measure, it should be demonstrated that the restoration project will be successful.

Water from dewatering activities should not be directed to alvar habitat if possible. If this is essential, a water budget should be completed so that existing hydro-period conditions can be matched during the extraction period.

Where quarries are situated adjacent to alvar habitat, appropriate dust suppression should always be undertaken on a regular basis to minimize effects.

ENERGY DEVELOPMENT

Biofuel farms are not considered likely on alvars or immediately adjacent to them as the shallow soils associated with alvars are generally unsuitable for crop production. There is potential for wind power facilities and solar farms to be developed on or adjacent to alvars.

Potential Development Effects: Wind Power Facilities

The open character of alvar habitat may make it attractive for wind power development. Alvar habitat will be destroyed where it is covered by turbine pads and access roads. Construction of permanent access roads also has the potential to affect retained alvar habitat through the introduction of non-native plant species. Additionally, if the road impedes surface water drainage, the flooding-drought cycle required by alvars may be altered with subsequent changes in vegetation on the alvar. Where drainage is not impeded, water may be retained on one side of the road resulting in excessive flooding on that side and insufficient water on the other side.

A wind power development adjacent to alvar habitat is unlikely to affect the neighbouring alvar, unless it changes the alvar's hydrologic regime.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of alvar habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). This distance is measured from the edge of the ecosite to the tip of the turbine blade when it is rotated toward the habitat (as opposed to from the base of the turbine). An alvar site must be >0.5 ha in size to be SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the alvar or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Eckhart Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on alvar habitat will result in loss of that portion of the habitat that is under the development footprint. The best mitigation is to avoid developing in the habitat. If complete avoidance is not possible, then the quality of the alvar needs to be considered in the site-selection process. Turbines and access roads should always be situated in lower quality areas as determined by an alvar expert; these areas may include the extreme edge of the habitat, areas with deeper soil that may evolve into another habitat type over time, areas with few or no obligate alvar plant species, and areas that support many non-native plants or species with low Coefficients of Conservatism.

Prior to development, the minimum area required for construction of the access roads and turbine pads should be fenced off and remain fenced until construction is complete. This will prevent heavy equipment from damaging alvar habitat that is to be retained.

Sufficient culverts should be installed under access roads to ensure that surface water drainage is not inhibited.

Thought needs to be given to minimizing disturbance to the alvar when installing transmission lines from turbines. Localized disturbance and loss of habitat will occur where excavations are made for the installation of poles to carry overhead wiring or trenches for buried wiring. If blasting through the alvar is essential, the substrate should be restored to a condition similar to pre-construction. Consideration should be given to installing the wiring under the footprint of the access road to minimize the disturbance footprint.

Potential Development Effects: Solar Power Facilities

The open character of alvar habitat may make it attractive for solar power development. Alvar habitat will be destroyed where it is covered to solar panels and access roads. By design, solar panels capture sunlight that would normally reach the habitat. A dramatic reduction in sunlight will have significant impacts on the underlying plant community, likely leading to the loss of species that are alvar obligates. In addition to physically destroying the habitat, permanent access roads have the potential to affect retained alvar habitat on either side of them. The disturbance associated with the road may result in a roadside proliferation of non-native plant species. Additionally, if the road impedes surface water drainage, the flooding-drought cycle required by alvars may be altered with subsequent changes in vegetation on the alvar. Where drainage is not impeded, water may be retained on one side of the road resulting in excessive flooding on that side and insufficient water on the other side.

A solar power development adjacent to alvar habitat is unlikely to affect the neighbouring alvar, unless it changes the alvar's hydrologic regime.

Mitigation Options: Solar Power Facilities

The siting of solar panels within 120 m of alvar habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). This distance is measured from the edge of the ecosite to the edge of the closest solar panel. An alvar site must be >0.5 ha in size to be SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the alvar or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on alvar habitat will result in loss of the habitat under the footprint of the solar farm. Avoidance of high-quality alvar habitat by development is the best mitigation option. Where complete avoidance is not possible, then the quality of the alvar needs to be considered in the site-selection process. Solar panels and access roads should always be situated in lower quality areas as determined by an alvar expert; these areas may include the extreme edge of the habitat, areas with deeper soil that may evolve into another habitat type over time, areas with few or no obligate alvar plant species, and areas that support many non-native plants or species with low Coefficients of Conservatism.

Prior to development, the minimum area required for construction of the access roads and panel arrays should be fenced off and remain fenced until construction is complete. This will prevent heavy equipment from damaging alvar habitat that is to be retained.

Sufficient culverts should be installed under access roads to ensure that surface water drainage is not inhibited.

Thought needs to be given to minimizing disturbance to the alvar when installing transmission lines from the solar farm. Localized disturbance and loss of habitat will occur where excavations are made for the installation of poles to carry overhead wiring or trenches for buried wiring. If blasting through the alvar is essential, the substrate should be restored to a condition similar to pre-construction. Consideration should be given to installing the wiring under the footprint of the access road to minimize the disturbance footprint.

ROAD DEVELOPMENT

Potential Development Effects

Roads may have both direct and indirect effects on alvars. Direct loss of habitat will occur if a road is built through an alvar. Indirect effects may occur as a result of creation of habitat more conducive to non-native plants or those that are not alvar species, changes in hydrology, and impacts from road de-icing activities.

Typical road construction involves a solid base of sand, gravel, or rock with an upper level of gravel frequently topped by asphalt or concrete. The top of the road is sloped down to the original grade and this slope is typically planted with grasses (mostly non-native species) and the area along the base of the road is often contoured to create ditches to remove surface water from the road and adjacent lands.

The footprint of the road and associated shoulders, banks, and ditches represent a direct loss of habitat. The disturbed nature of the banks and ditches promote colonization by non-native plant species which may also gain a foothold in any adjacent retained alvar habitat.

Depending upon their design, the ditches may result in a change in hydrology to the adjacent alvar. They may carry away water that is essential to the flooding-drought cycle of the alvar or cut off flow that would normally be directed to the alvar. The roadbed may also act as a hydrological barrier, with higher than normal water levels on one side of the road and lower than normal on the other. Changes in the hydrology can affect plant species composition on the alvar, and will most likely favour those species with a lower Coefficient of Conservatism. The alvar species with the most exacting microhabitat requirements may not survive if the hydrology is altered.

Compounds containing salt are typically used to de-ice roads in winter. Airborne salt spray can travel considerable distances depending upon wind velocity and the speed at which vehicles are traveling. Direct contact with salt spray can kill some species, and build-up of salt concentrations within surface and ground water over time may affect a wide variety of other species. Roadsides may also become dominated by halophytic plant species, most of which are non-native.

Additionally, numerous alvar fauna, especially snakes, may suffer due to road kill. Recent studies show that herpetofaunal road kill is especially prevalent when wetlands occur on both sides of the road (Langen et al. 2009). Some alvars, such as those dominated by tufted hairgrass, are wet for most of the year.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). An alvar site must be >0.5 ha in size to be SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on alvar habitat will result in loss of the habitat. Avoidance of high-quality alvar habitat by development is the best mitigation option. Where complete avoidance is not possible, site the road as close to the edge of the alvar as possible. If the road must go through an alvar, direct its route through areas of lesser quality (if these exist) as determined by an alvar expert. These areas may include areas with deeper soil that may evolve into another habitat type over time, areas with few or no obligate alvar plant species, and areas that support many non-native plants or species with low Coefficients of Conservatism.

The construction area needs to be fenced off prior to and during construction to ensure that no equipment or heavy machinery enters the part of the alvar that will be retained.

Minimize the footprint of any road that must be routed through alvar habitat. Design the road for construction as close to the existing grade as possible; this will result in less area being covered by the road and its banks, thereby minimizing the amount of habitat destroyed. Smaller banks also means less area likely to support non-native plant species.

If possible, ditches should not be constructed along the road through the alvar. If ditches are essential, they should be constructed so that they are above the original grade of the alvar instead of excavating into the alvar surface. Excavation below the alvar surface has high potential to alter the hydrology of the alvar.

Sufficient culverts should be installed under the road to allow water to flow unimpeded from one side to the other. If this is done properly and ditches do not remove the water, this should help to maintain the hydrology of the alvar.

Roadsides through alvars should never be planted with the mix of grasses and legumes that are typically used for agriculture. Some of these have the potential to invade the alvar and be detrimental to native plant species. Roadsides should always be planted with a native wildflower or grass mix and the mix should be checked by a qualified person to ensure that it actually is native, as many wildflower and grass mixes contain non-native species.

No herbicides should be used along the roadside to control vegetation.

Consideration should be given to using de-icing compounds other than salt through alvar habitat.

If mortality of amphibians or reptiles is a potential impact, mitigation measures indicated in Index #13 and Index #15 should be implemented.

INDEX #18: SAVANNAH

Ecoregions:	5E, 6E and 7E
Species Group:	Savannah
Significant Wildlife Habitat Category:	Rare Vegetation Community
Functional Habitat:	Preferred Habitat
Habitat Features:	Tallgrass prairie with 25-60% tree cover

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Savannahs are characterized by widely-spaced, open-grown trees producing canopy closure of approximately 25 to 60% (Lee et al. 1998; OMNR 2000). Communities with 25 to 35% tree canopy closure are classified as tallgrass savannahs while those with 35 to 60% tree coverage are classified as tallgrass woodlands (Lee et al. 1998). These trees typically grow in association with an assortment of grasses and forbs that are characteristic of prairie communities (OMNR 2000). Gore & Storrie Limited (1993 [prepared by W.D. Bakowsky]) provided an overview of the characteristics and distribution of southern Ontario savannahs.

It should be noted that the Ecological Land Classification (ELC) also recognizes cultural savannahs. These communities have scattered trees resulting from active planting or from natural regeneration, but they lack the prairie community in the understory that is characteristic of true savannahs. Cultural savannahs are not considered rare vegetation communities. Poorly stocked and barren and scattered stands as depicted on Forest Resource Inventory maps should not be considered savannahs for the purposes of the significant wildlife habitat policy unless they have the appropriate canopy and understory characteristics (OMNR 2000).

Soil depth of true savannahs is variable and the soils are usually underlain by limestone bedrock. The soils are often fine sandy loams or sand, and Farmington loams. In the spring, some savannahs are often saturated and internal drainage is restricted due to the underlying bedrock or clay. In mid- to late summer, these soils dry out, frequently creating drought-like conditions. Other savannahs are excessively well-drained, having developed on sands over well-sorted gravel. Savannah communities are maintained by fire which controls the invasion of woody shrubs and non-native species of grasses (OMNR 2000). In some instances, it may be necessary for a qualified agency to conduct controlled burns in areas where fire is typically suppressed.

The trees in savannah communities are usually oaks and hickories, primarily black oak, bur oak, and pignut hickory on dry to mesic sites. Black oak is the dominant species in southwestern Ontario savannahs and is replaced by red oak farther north. Other species on dry to mesic sites include white oak, white and red pine, and red cedar (OMNR 2000). Pin and swamp white oaks are the dominant tree species in wetter savannah communities (Lee et al. 1998).

Some understory plant species that are dominant in savannah communities or indicators of savannah habitat include big bluestem, yellow pimpernel, wild bergamot, woodland sunflower, smooth-leaved aster, and wild lupine (Rodger 1998).

Similar to alvar plant species, the plants that inhabit certain savannahs are highly adapted to the cycle of very wet conditions in spring and very dry habitat in summer. Conversely, some savannahs are very dry all the time and not adapted to wet conditions in spring. Savannahs are also adapted to fire, which prevents trees from fully establishing and developing a closed canopy. Consequently, many savannah species have a high Coefficient of Conservatism and several of them are species of conservation concern. The Red-headed Woodpecker, a species at risk in Ontario, was probably originally restricted primarily to savannah habitat prior to forest clearing by European settlers. Its preferred habitat is oak savannah, with widely spaced mature oak or hickory trees and an understory of grasses (Graber and Graber 1963; Conner 1976; Conner and Adkisson 1977; Graber et al. 1977; Peck and James 1983). The decline of this woodpecker is probably linked to the loss of almost all of the original savannah habitats in Ontario coupled with changes in forest management practices that make other woodlands less suitable for it.

All of the savannah types found in Ontario are provincially and globally significant (Bakowsky 1996).

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Residential or commercial development within savannah habitat will result in its loss, and development adjacent to savannahs has the potential to impact this significant community type.

If development activities change the amount of water that is directed toward the savannah, or if the timing of delivery of water to the savannah is altered, there is the potential to completely change the understory of the community, and ultimately the overstory. If the drought, or flooding-drought cycle is interrupted or significantly altered, the savannah species with high Coefficients of Conservatism will probably not be able to maintain themselves. These are usually the most significant plant species present and those that are characteristic of savannah habitat. Species with more exacting microclimate requirements are likely to be replaced with more tolerant and common plant species. Interruption of the natural water cycle in a savannah usually results in a proliferation of shrub species, and the shrubs tend to crowd out the shade-intolerant understory. If shrub density becomes too high, regeneration of tree species in the savannah may be seriously inhibited, as most savannah tree species are shade intolerant and grow in open conditions.

Development of adjacent lands may make it more difficult to manage the savannah habitat. In southern Ontario, wildfires are suppressed, yet savannahs require periodic fires to inhibit invasion by woody species. In order to maintain savannahs, it is necessary to conduct occasional controlled burns. The presence of adjacent housing makes it much more difficult to conduct these management techniques and often an extensive public education program and public consultation is necessary to conduct a controlled burn. In some cases, concern of the neighbours may be such that a controlled burn is not feasible.

Development adjacent to a savannah has the potential to introduce edge effects to the habitat. This may include degradation at the edge of the savannah due to introduction of weeds from adjacent developed areas and from landowners extending their properties into the savannah or using it as an area in which to dispose of yard waste.

Adjacent landowners may find the savannah unsightly as it may appear to be a wild area that is overgrown with grasses. There may be subsequent pressure to "clean up" the savannah which may result in alteration of the habitat depending upon the measures taken. On the other hand, periodic mowing of the habitat might actually be beneficial by suppressing shrub growth.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ecosite is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on savannah habitat will result in loss of the habitat. Avoidance is the best mitigation option. Development in lands adjacent to savannahs needs to be set back far enough to prevent edge effects due to landowner encroachment and dumping of material.

A water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the savannah, and that there will be no change in hydro-period. Lots should always be graded such that water is not directed toward the savannah and ideally all development would be outside of the savannah's watershed. Stormwater management facilities should never be located within savannah habitats.

Significant savannah areas that are set aside from development should be turned over to a public agency such as a conservation authority so that agency can undertake the management required (e.g., controlled burning) to maintain the habitat.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf course development is the only major recreational development likely to occur within or adjacent to savannah habitat.

Unless they are properly laid out to avoid high-quality savannah habitat, fairways, tees, and greens (also buildings, parking lots, roadways) will result in the direct loss of savannah habitat.

If golf courses change the amount of water that is directed toward the savannah through grading or irrigation, or if the timing of delivery of water to the savannah is altered, there is the potential to completely change the understory of the community. If the drought, or flooding-drought cycle is interrupted or significantly altered, the savannah species with high Coefficients of Conservatism will probably not be able to maintain themselves. These are usually the most significant plant species present and those that are characteristic of savannah habitat. Species with more exacting microclimate requirements are likely to be replaced with more tolerant and common plant species. Interruption of the natural water cycle in a savannah usually results in a proliferation of woody species which tend to crowd out the shade-intolerant understory. If shrub density becomes too high, regeneration of tree species in the savannah may be seriously inhibited, as most savannah tree species are shade intolerant and grow in open conditions. If tree density increases too much, the understory characteristic of savannah may be lost.

Chemicals typically used for golf course maintenance have the potential to adversely affect savannah habitat, especially some of the more sensitive plant species.

Development of a golf course or portions of a golf course immediately adjacent to a savannah also has the potential to introduce edge effects to the habitat. This may include degradation at the edge of the savannah due to introduction of plant species not typical for savannahs from adjacent developed areas.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ecosite is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on savannah habitat will result in loss of the habitat. The best mitigation option is to avoid developing in the habitat.

Savannahs and golf course development can be compatible if the golf course is carefully designed to avoid direct loss of savannah habitat and if a commitment is made to actively manage the retained savannah habitat. For example, insecticides, herbicides and fungicides used on adjacent golf course surfaces should not touch savannah habitat. Additionally, areas of the golf course that are dominated by cultural vegetation communities could be converted to savannah habitat. Areas of rough could also be converted to savannah. These actions may help avoid edge effects (e.g., introduction of non-savannah plant species) in adjacent savannah habitat.

A water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the savannah, and that there will be no change in hydro-period. New drainage, for example from parking lots, club houses, and maintenance areas, should not be directed toward the savannah. If these facilities are within the existing drainage for the savannah, water should be treated prior to release to the savannah.

Significant savannah areas that are set aside from development should be turned over to a public agency such as a conservation authority so that agency can undertake the management required (e.g., controlled burning) to maintain the habitat.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Sand and gravel are the only types of aggregates likely to be available in savannah habitat. Limestone quarries may occur in bur oak-shagbark hickory savannahs located on the shallow soils of limestone bedrock. Extraction of sand and gravel within savannahs will result in at least the temporary loss of savannah habitat, and the permanent loss of some of its components. Even if these areas are rehabilitated, it is unlikely that all the components of the savannah will be restored due to loss of the soil A-horizon and seedbank.

If extraction is conducted below the water table, the loss of savannah habitat will be permanent as the end rehabilitation of the pit will be to a lake or wetland habitat.

Aggregate development on adjacent lands also has the potential to alter savannah communities. Direct loss may occur if berms for visual and noise barriers are constructed on top of savannah habitat. Savannah habitat may also be affected if water from the quarry is pumped into it or a pond is created on it, or if the surface water regime is otherwise affected by quarry activities.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ecosite is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Aggregate extraction from savannah habitat will result in loss of that portion of the habitat that is under the footprint of the development. The best mitigation option is to avoid developing sand and gravel pits and limestone quarries in savannah habitat. Where complete avoidance is not possible, an effort must be made to retain at least some of the habitat as a subsequent seed source which will ensure that not all savannah habitat is lost. If possible, only lower quality areas of the savannah, as determined by a savannah habitat expert, should be used for aggregate extraction. These will include areas where the understory is weedy or has a high density of shrubs, and there are few obligate savannah plant species present. It must be recognized, however, that areas such as these have the potential to become high quality habitat if they are managed by controlled burns. Areas should not be discounted as being poor habitat until some management techniques have been applied.

It may be possible, over time, to mitigate the loss of the original savannah under the footprint of the development. Once the resources are exhausted, consider rehabilitating pits or quarries that have not been extracted below the water table to savannah habitat. Savannah habitat can be restored by planting native prairie grasses and a scattering of black oak or other appropriate tree species. Historical descriptions of vegetation communities completed by the original land surveyors may be useful in determining where savannahs historically occurred; these areas will likely have the best potential for savannah restoration. Additionally, adjacent retained habitat will provide an appropriate seed source. Examples exist in Ontario of savannah ecosystems in abandoned pit and quarry sites (Browning and Tan 2002).

Water from dewatering activities should not be directed to savannah habitat if possible. If this is essential, a water budget should be completed so that existing hydro-period conditions can be matched during the extraction period.

It is unlikely that a limestone quarry could be restored to savannah habitat.

ENERGY DEVELOPMENT

Potential Development Effects: Biofuel Farms

The ploughing and subsequent conversion of natural grasslands and scattered trees to farmland for the production of crops for ethanol (e.g., biomass feedstock such as corn and soy) will destroy savannah habitat.

Mitigation Options: Biofuel Farms

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ecosite is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on savannah habitat will result in loss of the habitat. The best mitigation is to avoid developing biofuel farms in savannah habitat. Savannahs and biofuel farms can be compatible if the farm is sited to avoid direct loss of savannah habitat and if a commitment is made to actively manage the retained savannah habitat. For example, insecticides, herbicides, fungicides and fertilizers used on crops should not touch savannah habitat. Additionally, the boundary area between the farm and the savannah should be sufficiently broad to prevent degradation of the adjacent savannah through edge effects (e.g., introduction of non-savannah plant species).

Consider cultivating Switchgrass rather than corn or soy for biofuel production. Switchgrass is a native, perennial warm season grass that can still be found in remnant oak savannahs in Ontario (Samson 2007). Because it is a savannah species, cultivating Switchgrass may help mitigate the edge effect on adjacent savannah habitat. Cultivating Switchgrass may also benefit grassland nesting birds because it is harvested after the nesting period; its use may actually serve to increase nesting habitat for grassland birds (Samson 1991).

A water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the savannah, and that there will be no change in hydro-period. Drainage from fields of crops should not be directed toward the savannah. If the farm is within the existing drainage for the savannah, water should be treated prior to release to the savannah.

Significant savannah areas that are set aside from development should be turned over to a public agency such as a conservation authority so that agency can undertake the management required (e.g., controlled burning) to maintain the habitat.

Potential Development Effects: Wind Power Facilities

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Clearing for wind energy development in savannah habitat represents a direct loss of the habitat. Additionally, construction of permanent access roads on savannah habitat destroys the habitat; it also has the potential to affect retained savannah habitat through the introduction of non-native plant species.

If access roads impede natural drainage, the moisture regime of the savannah could be disrupted and adversely affect species with high Coefficients of Conservatism while promoting establishment of non-native plant species or those with lower Coefficients of Conservatism. Where drainage is not impeded, water may be retained on one side of the road resulting in excessive flooding on that side and insufficient water on the other side.

A wind power development adjacent to savannah habitat is unlikely to affect the neighbouring savannah, unless it changes the savannah's hydrologic regime.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of savannah habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). This distance is measured from the edge of the ecosite to the tip of the turbine blade when it is rotated toward the habitat (as opposed to from the base of the turbine). The area of the ecosite is the SWH; there is no minimum size. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the savannah or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Eckhart Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on savannah habitat will result in loss of the habitat. The best mitigation is to avoid developing wind power facilities in savannah habitat. Where they exist, areas of lower quality grassland adjacent to the savannah should be selected for development instead. These areas may include: the edge of the savannah; areas where there are few, if any, species with a high Coefficient of Conservatism; and areas where species diversity is low and there are some non-native plant species present.

The development should be designed and sited such that as little savannah habitat as possible is affected. Areas where construction will occur should always be fenced off prior to and during development so that equipment and machinery do not have access to the savannah habitat that will be retained.

The footprint of any access roads that affect savannah habitat should be minimized so that as little habitat is destroyed as possible. Sufficient culverts should be installed under access roads to ensure that there is free movement of water under the roads.

Consider installing power transmission lines under the access road right-of-way to minimize disturbance of savannah habitat.

If the site contains areas with cultural vegetation communities (i.e. typical agricultural grasses), thought should be given to restoring these to savannah habitat provided that the soils are suitable.

Potential Development Effects: Solar Power Facilities

Vegetation clearing in savannah habitat for development will destroy the affected habitat. Even where vegetation is not cleared, e.g., a tallgrass savannah, the installation of solar panels in the habitat will result in its loss. By design, solar panels capture sunlight that would normally reach the habitat. A dramatic reduction in sunlight will have significant impacts on the underlying plant community, likely leading to the loss of biomass and structure.

Development on lands adjacent to savannah habitat can also be detrimental if it changes the water regime (quantity, timing, quality of water) of the habitat. Altered hydrology has the potential to completely change the understory of the community, and ultimately the overstory. If the drought, or flooding-drought cycle is interrupted or significantly altered, the savannah species with high Coefficients of Conservatism will probably not be able to maintain themselves. These are usually the most significant plant species present and those that are characteristic of savannah habitat. Species with more exacting microclimate requirements are likely to be replaced with more tolerant and common plant species. Interruption of the natural water cycle in a savannah usually results in a proliferation of shrub species, and the shrubs tend to crowd out the shade-intolerant understory. If shrub density becomes too high, regeneration of tree species in the savannah may be seriously inhibited, as most savannah tree species are shade intolerant and grow in open conditions.

Development adjacent to a savannah also has the potential to introduce edge effects to the habitat, e.g., degradation at the edge of the savannah due to introduction of weeds from adjacent developed areas.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of savannah habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The area of the ecosite is the SWH; there is no minimum size. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the savannah or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing in savannah habitat for development will destroy the affected habitat, and may reduce the ecological function of adjacent retained habitat through edge effects and hydrologic changes. The best mitigation option is to avoid developing in the habitat. Where complete avoidance is not possible, the development should be designed and sited such that as little savannah habitat as possible is affected (e.g., the edge of the savannah; areas where there are few, if any, species with a high Coefficient of Conservatism; areas where species diversity is low and there are some non-native plant species present).

Areas where construction will occur should always be fenced off prior to and during development so that equipment and machinery do not have access to savannah habitat that will be retained.

A water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the savannah, and that there will be no change in hydro-period. The developed area should be graded such that water is not directed toward the savannah and ideally all development would be outside of the savannah's watershed. Stormwater management facilities should never be located within savannah habitats.

Consider installing power transmission lines under the access road right-of-way to minimize disturbance of retained savannah habitat.

If undeveloped portions of the site contain areas with cultural vegetation communities (i.e. typical agricultural grasses), thought should be given to restoring these to savannah habitat provided that the soils are suitable.

Development in lands adjacent to savannahs needs to be set back far enough to prevent edge effects.

ROAD DEVELOPMENT

Potential Development Effects

Roads may have both direct and indirect effects on savannahs. Direct loss of habitat will occur if a road is built through a savannah. Indirect effects may occur as a result of creation of habitat more conducive to non-native plants or those that are not savannah species, changes in hydrology, and impacts from road de-icing activities.

Typical road construction involves a solid base of sand, gravel, or rock with an upper level of gravel frequently topped by asphalt or concrete. The top of the road is sloped down to the original grade and this slope is typically planted with grasses (mostly non-native species) and the area along the base of the road is often contoured to create ditches to remove surface water from the road and adjacent lands.

The footprint of the road and associated shoulders, banks, and ditches represent a direct loss of habitat. The disturbed nature of the banks and ditches promote colonization by non-native plant species which may also gain a foothold in the adjacent retained savannah habitat.

Depending upon their design, the ditches may result in a change in hydrology to the adjacent savannah. They may carry away water that is essential to the flooding-drought cycle of the savannah or cut-off flow that would normally be directed to the savannah. The roadbed may also act as a hydrological barrier, with higher than normal water levels on one side of the road and lower than normal on the other. Changes in hydrology can affect plant species composition in the savannah, and will most likely favour those species with a lower Coefficient of Conservatism. The savannah species with the most exacting microhabitat requirements may not continue to survive if the hydrology is altered.

Compounds containing salt are typically used to de-ice roads in winter. Airborne salt spray can travel considerable distances depending upon wind velocity and the speed at which vehicles are traveling. Direct contact with salt spray can kill some species, and build-up of salt concentrations within surface and ground water over time may affect a wide variety of other species. Roadsides may also become dominated by halophytic plant species, most of which are non-native.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ecosite is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on savannah habitat will result in loss of the habitat. Where complete avoidance is not possible, site the road as close to the edge of the savannah as possible. If the road must go through a savannah, direct its route through areas of lesser quality (if these exist) as determined by a savannah habitat expert. Areas with mature trees should be avoided if possible. Examples of lesser quality habitat include sites where soils are deeper and where natural succession may eventually result in the savannah evolving into another type of habitat, areas where there are few obligate savannah plant species, and areas where the savannah supports non-native plant species or species with low Coefficients of Conservatism.

The construction area should always be fenced off prior to and during construction to ensure that no equipment or heavy machinery enters the part of the savannah that will be retained.

Remove and stockpile all topsoil from the road right-of-way, and use it later to form the banks of the road. This soil will be suitable to support plantings of savannah grasses. Roadsides through savannahs should not be planted with the mix of grasses and legumes that is typically used (e.g., agriculture grass and legume mixes). Some of the grasses and legumes in these mixes have the potential to invade the savannah and be detrimental to native plant species. Plant roadsides in or adjacent to savannah habitat with savannah species, preferably using the existing savannah as a seed source.

Minimize the footprint of any road that must be routed through savannah habitat. Design the road for construction as close to the existing grade as possible; this will result in less area being covered by the road and its banks, thereby minimizing the amount of habitat destroyed.

If possible, ditches should not be constructed along the road through the savannah. If ditches are essential, they should be constructed so that they are above the original grade of the savannah instead of excavating into the existing surface. Excavation below the savannah surface has high potential to alter the hydrology. Sufficient culverts need to be installed under the road to allow water to flow unimpeded from one side to the other. If this is done properly and ditches do not remove the water, this should help to maintain the hydrology of the savannah.

No herbicides should be used along the roadside to control vegetation.

Consideration should be given to using de-icing compounds other than salt through savannah habitat.

INDEX #19: TALLGRASS PRAIRIE

Ecoregions:	5E, 6E and 7E
Species Group:	Tallgrass Prairie
Significant Wildlife Habitat Category:	Rare Vegetation Community
Functional Habitat:	Preferred Habitat
Habitat Features:	Groundcover dominated by prairie grasses; an open tallgrass prairie habitat has < 25% tree cover The Dense Blazing-star (THREATENED) may be an associate of fresh-moist tallgrass prairies. Prairies may also support Henslow's Sparrow (ENDANGERED) and American Badger (ENDANGERED). All of these species are protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that may affect these species.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

The once extensive tallgrass prairies in Ontario are now predominantly reduced to small remnants that are less than 1 ha in area, although larger areas remain on Walpole Island, the Ojibway Complex in Windsor, and near Alderville south of Rice Lake. Most remaining prairies are in southwestern Ontario, including those on the following landforms: Horseshoe Moraines, Caradoc Sand Plains, Bothwell Sand Plains, St. Clair Sand Plains, Norfolk Sand Plain, and the Peterborough Drumlin Field (OMNR 2000). Gore & Storrie Limited (1993 [prepared by W.D. Bakowsky]) provided an overview of the characteristics and distribution of southern Ontario prairies.

High-quality prairies have few trees or non-native plant species and are dominated by native grasses and herbs. Indicator species include big bluestem, little bluestem, Indian grass, cordgrass, and switch grass. Soil depth in prairies is variable but they are usually several metres deep and typically fine textured, ranging from dry-mesic sands to wet-mesic sandy loams over limestone bedrock (OMNR 2000). Tallgrass prairies are subject to seasonal extremes in moisture conditions. The plant communities indicative of these habitats are adapted to spring flooding followed by summer drought (Lee et al. 1098).

Prairies are very susceptible to natural succession and subsequent invasion by woody species and by non-native plant species when they are disturbed. These habitats must be frequently disturbed by fire to maintain their open condition. Fire inhibits the establishment and growth of shrub and tree species. In areas where fires are suppressed, controlled burning is necessary to maintain the quality of tallgrass prairies. Many of the remaining prairies contain invasive plant species (OMNR 2000).

It should be recognized that tallgrass prairies may maintain a seedbank of significant plant species for several decades. A prairie that appears to be degraded and of very low quality can potentially be rejuvenated by a controlled burn that inhibits or reduces the growth of non fire-adapted species, and also releases the seedbank. This simple type of management may convert a low-quality prairie into a high-quality prairie over time. Before deciding that a remnant prairie habitat is not significant, management efforts need to be undertaken to see if it can be improved by reversing natural succession.

Two types of tallgrass prairie have been recognized in Ontario: dry tallgrass prairie and fresh-moist tallgrass prairie (Lee et al. 1998; NHIC 2007). Both of these communities are provincially and globally significant (Bakowsky 1996). Associates of dry prairies include cyclindric anemone, rock sandwort, pinweed, Scribner's panic grass, and bluets, while gray coneflower, prairie dock, and ironweed may be associates of fresh-moist prairies (Lee et al. 1998).

On high-quality tallgrass prairies a high proportion of the plant species present are provincially significant. Some of the plant species are obligate prairie species that rarely occur in other habitats.

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

The open character of tallgrass prairie habitat may make it attractive for residential subdivision development and commercial development. Development on tallgrass prairie will destroy the habitat.

Where residential or commercial areas are developed adjacent to tallgrass prairie habitat, hydrologic effects may occur if the amount of water directed toward the prairie is changed through grading, drainage or runoff, or if the timing of water delivery to the prairie is altered. Hydrologic changes have the potential to change the composition of prairie plant communities. If the hydrology flooding-drought cycle is interrupted or significantly altered, the prairie species with high Coefficients of Conservatism will probably not be able to maintain themselves. These are usually the most significant plant species present and those that are characteristic of prairie habitat. Species with more exacting microclimate requirements are likely to be replaced with more tolerant and common plant species. Interruption of the natural water cycle in a prairie usually results in a proliferation of shrub species, and the shrubs tend to crowd out the shade-intolerant understory.

Development on lands adjacent to tallgrass prairie may make it more difficult to manage the prairie habitat. In southern Ontario, wildfires are suppressed, yet prairies require periodic fires to inhibit invasion of the habitat by woody vegetation. In order to maintain prairies, it is usually necessary to conduct occasional controlled burns. The presence of adjacent housing or commercial development makes it much more difficult to conduct these management actions. Extensive public education and public consultation are necessary to conduct a controlled burn. In some cases, concern of the neighbours may be such that a controlled burn is not feasible.

Development adjacent to a prairie also has the potential to introduce edge effects to the habitat. This may include degradation at the edge of the prairie due to introduction of weeds from adjacent developed areas and from landowners extending their properties into the prairie or using it as an area in which to dispose of materials.

Adjacent landowners may find the prairie unsightly as it may appear to be a wild area that is overgrown with grasses. There may be subsequent pressure to "clean up" the prairie which may result in alteration of the habitat depending upon the measures taken. On the other hand, occasional mowing of the habitat might actually be beneficial in suppressing shrub growth.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC vegetation type is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on tallgrass prairie habitat will result in loss of the habitat under the development footprint, and reduced ecological function of the remaining habitat due to edge effects and succession. The best mitigation option is to avoid developing on the habitat.

Development on lands adjacent to prairies need to be set back sufficiently so that edge effects are not experienced due to encroachment and dumping of materials. A water balance study should also be completed so that it can be demonstrated that there will be no discernable change in the quantity or quality of water that is directed to the prairie, and that there will be no change in hydro-period. New drainage, for example from driveways, roofs, and parking lots, should never be directed toward the prairie. If these structures are within the existing drainage for the prairie, water should be treated prior to release to the prairie.

Under certain circumstances, it may be possible to create prairie habitat. Ideally, this option would be used to create additional prairie habitat instead of being used as a mitigation measure for replacement of an existing prairie. In order to be successful, suitable soils must be present and this needs to be determined by completing a soil survey. Historical descriptions of vegetation communities completed by the original land surveyors may be useful in determining where prairies historically occurred; these areas will likely have the best potential for prairie restoration. Prior to implementing a prairie restoration project, a management plan needs to be prepared that identifies the plant communities that will be established, the source of the native seeds, and the required management to ensure that the prairie becomes suitably established and is maintained as a high-quality habitat.

Significant tallgrass areas that are set aside from development should be turned over to a public agency such as a conservation authority so that agency can undertake the management required (e.g., controlled burning) to maintain the habitat.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses are the type of major recreational development that is most likely to affect prairies. Unless they are properly laid out to avoid high-quality prairie habitat, development of fairways, tees, and greens will result in the direct loss of prairie habitat.

Where golf courses are developed adjacent to tallgrass prairie habitat, hydrologic effects may occur if the amount of water directed toward the prairie is changed through grading or irrigation, or if the timing of water delivery to the prairie is altered. Hydrologic changes have the potential to change the composition of prairie plant communities. If the hydrology flooding-drought cycle is interrupted or significantly altered, the prairie species with high Coefficients of Conservatism will probably not be able to maintain themselves. These are usually the most significant plant species present and those that are characteristic of prairie habitat. Species with more exacting microclimate requirements are likely to be replaced with more tolerant and common plant species. Interruption of the natural water cycle in a prairie usually results in a proliferation of shrub species, and the shrubs tend to crowd out the shade-intolerant understory.

Chemicals typically used on golf courses have the potential to adversely affect prairie habitat, especially some of the more sensitive plant species.

Development of a golf course or portions of a golf course immediately adjacent to a prairie also has the potential to introduce edge effects to the habitat. This may include degradation at the edge of the prairie due to introduction of weeds from adjacent developed areas.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC vegetation type is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on tallgrass prairie habitat will result in loss of the habitat under the development footprint, and reduced ecological function of the remaining habitat due to edge effects and succession. The best mitigation option is to avoid developing in the habitat.

Prairies and golf course development can be compatible if the golf course is carefully designed to avoid direct loss of prairie habitat and if a commitment is made to actively manage the retained prairie habitat. For example, insecticides, herbicides and fungicides used on adjacent golf course surfaces should not touch prairie habitat. Additionally, areas of the golf course that are dominated by cultural vegetation communities could be converted to prairie habitat. Areas of rough could also be converted to prairie. These actions may help avoid edge effects (e.g., introduction of non-prairie plant species) in adjacent prairie habitat.

In some cases, the periphery of a prairie may be of slightly lesser quality due to edge effects that have resulted in degradation due to invasion by non-native plant species, woody species, and native plant species that are not characteristic of prairie communities. Prior to deciding that these areas are of low quality, a controlled burn needs to be conducted to see if these sites can be restored.

A water balance study should be completed so that it can be demonstrated that there will be no discernable change in the quantity or quality of water that is directed to the prairie, and that there will be no change in hydro-period. New drainage, for example from parking lots, club houses, and maintenance areas, should never be directed toward the prairie. If these facilities are within the existing drainage for the prairie, water should be treated prior to release to the prairie.

Significant tallgrass areas that are set aside from development should be turned over to a public agency such as a conservation authority so that agency can undertake the management required (e.g., controlled burning) to maintain the habitat.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Sand and gravel are the only types of aggregates likely to be available in prairie habitat. Extraction of sand and gravel within prairies will result in at least the temporary loss of prairie habitat, and the permanent loss of some of its components. Even if these areas are rehabilitated, it is unlikely that all the components of the prairie will be restored due to loss of the soil A-horizon and seedbank.

If extraction is conducted below the water table, the loss of prairie habitat will be permanent as the end rehabilitation of the pit will be to a lake or wetland habitat.

Aggregate development on adjacent lands also has the potential to alter prairie communities. Direct loss may occur if berms for visual and noise barriers are constructed on top of prairie habitat. Prairie habitat may also be affected if water from the quarry is pumped into it or a pond is created on it, or if the surface water regime is otherwise affected by quarry activities.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC vegetation type is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on tallgrass prairie habitat will result in loss of that portion of the habitat that is under the development footprint. The best mitigation option is to avoid developing sand and gravel pits in prairie habitat. Where complete avoidance is not possible, an effort must be made to retain at least some of the habitat as a subsequent seed source which will ensure that not all prairie habitat is lost. If possible, only lower quality areas of the prairie, as determined by a tallgrass prairie habitat expert, should be used for aggregate extraction. These will include areas that have been degraded by invasion of non-native plants, woody plants, or native species that are not characteristic of tallgrass prairie habitat. It must be recognized, however, that areas such as these have the potential to become high quality habitat if they are managed by controlled burns. Areas should not be discounted as being poor habitat until some management techniques have been applied.

It may be possible, over time, to mitigate the loss of the habitat under the footprint of the development. Once the resources are exhausted, consider rehabilitating pits or quarries that have not been extracted below the water table to tallgrass prairie habitat. Prairie habitat can be restored by planting native prairie grasses and other appropriate herbaceous species. Historical descriptions of vegetation communities completed by the original land surveyors may be useful in determining where prairies historically occurred; these areas will likely have the best potential for prairie restoration. Additionally, adjacent retained habitat will provide an appropriate seed source. Examples exist in Ontario of tallgrass prairie ecosystems in abandoned pit and quarry sites (Browning and Tan 2002).

Water from dewatering activities should not be directed to prairie habitat if possible. If this is essential, a water budget should be completed so that existing hydro-period conditions can be matched during the extraction period.

ENERGY DEVELOPMENT

Potential Development Effects: Biofuel Farms

The ploughing and subsequent conversion of tallgrass prairie to farmland for the production of crops for ethanol (e.g., biomass feedstock such as corn and soy) will destroy tallgrass prairie habitat.

Irrigation and drainage of agricultural fields adjacent to tallgrass prairie may disrupt the hydrologic regime of the prairie. Changes in the water regime have the potential to adversely affect species with high Coefficients of Conservatism while promoting establishment of non-native plant species or those with lower Coefficients of Conservatism.

Mitigation Options: Biofuel Farms

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC vegetation type is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on tallgrass prairie habitat will result in loss of that portion of the habitat that is under the development footprint. The best mitigation is to avoid developing biofuel farms in prairie habitat.

Prairies and biofuel farms can be compatible if the farm is sited to avoid direct loss of prairie habitat and if a commitment is made to actively manage the retained prairie habitat. For example, insecticides, herbicides, fungicides and fertilizers used on crops should not touch prairie habitat. Additionally, the boundary area between the farm and the prairie should be sufficiently broad to prevent degradation of the adjacent prairie through edge effects (e.g., introduction of non-prairie plant species).

Consider cultivating Switchgrass rather than corn or soy for biofuel production. Switchgrass is a native, perennial warm season grass that is a core prairie species in Ontario (Tallgrass Ontario 2004). Because it is a prairie species, cultivating Switchgrass may help mitigate the edge effect on adjacent prairie habitat. Cultivating Switchgrass may also benefit grassland nesting birds because it is harvested after the nesting period; its use may actually serve to increase nesting habitat for grassland birds (Samson 1991).

A water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the prairie, and that there will be no change in hydro-period. Drainage from fields of crops should not be directed toward the prairie. If the farm is within the existing drainage for the prairie, water should be treated prior to release to the prairie.

Significant tallgrass areas that are set aside from development should be turned over to a public agency such as a conservation authority so that agency can undertake the management required (e.g., controlled burning) to maintain the habitat.

Potential Development Effects: Wind Power Facilities

The open character of tallgrass prairie habitat may make it attractive for wind power development. Prairie habitat will be destroyed where it is covered by turbine pads and access roads, and where poles or buried transmission lines are installed. Construction of permanent access roads also has the potential to affect retained prairie habitat through the introduction of non-native plant species. Additionally, if the road impedes surface water drainage, the flooding-drought cycle required by prairies may be altered with subsequent changes in vegetation on the prairie. Where drainage is not impeded, water may be retained on one side of the road resulting in excessive flooding on that side and insufficient water on the other side. Disruption of the hydrologic regime has the potential to adversely affect species with high Coefficients of Conservatism while promoting establishment of non-native plant species or those with lower Coefficients of Conservatism.

A wind power development adjacent to prairie habitat is unlikely to affect the neighbouring prairie, unless it changes the prairie's hydrologic regime.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of tallgrass prairie habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). This distance is measured from the edge of the ecosite to the tip of the turbine blade when it is rotated toward the habitat (as opposed to from the base of the turbine). The area of the ELC vegetation type is the SWH; there is no minimum size. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the prairie or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Eckhart Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on prairie habitat will result in loss of that portion of the habitat that is under the development footprint. The best mitigation is to avoid developing wind power facilities in prairie habitat. Where complete avoidance is not possible, then the quality of the prairie needs to be considered in the site-selection process. Turbines and access roads should always be situated in lower quality areas as determined by a tallgrass prairie expert. These will include areas that have been degraded by invasion of non-native plants, woody plants, or native species that are not characteristic of tallgrass prairie habitat. It must be recognized, however, that areas such as these have the potential to become high quality habitat if they are managed by controlled burns. Areas should not be discounted as being poor habitat until some management techniques have been applied.

Prior to development, the minimum area required for construction of the access roads and turbine pads should be fenced off and remain fenced until construction is complete. This will prevent heavy equipment from damaging prairie habitat that is to be retained.

The footprint of any access roads that affect tallgrass prairie habitat should be minimized so that as little habitat is destroyed as possible. Sufficient culverts should be installed under access roads to ensure that surface water drainage is not inhibited.

Thought needs to be given to minimizing disturbance to the prairie when installing transmission lines from turbines. Localized disturbance and loss of habitat will occur where excavations are made for the installation of poles to carry overhead wiring or trenches for buried wiring. If excavation is essential, the substrate should be restored to a condition similar to pre-construction. Consideration should be given to installing the wiring under the footprint of the access road to minimize the disturbance footprint.

If the site contains areas with cultural vegetation communities, thought needs to be given to restoring these to prairie habitat provided that the soils are suitable.

Potential Development Effects: Solar Power Facilities

Vegetation clearing in tallgrass prairie habitat for development will destroy the affected habitat. Even where vegetation is not cleared, the installation of solar panels in the habitat will result in its loss. By design, solar panels capture sunlight that would normally reach the habitat. A dramatic reduction in sunlight will have significant impacts on the underlying plant community, likely leading to the loss of biomass and structure.

For development adjacent to tallgrass prairie habitat, hydrologic effects may occur if the amount of water directed toward the prairie is changed through grading, drainage or runoff, or if the timing of water delivery to the prairie is altered. Hydrologic changes have the potential to change the composition of prairie plant communities. If the hydrology flooding-drought cycle is interrupted or significantly altered, the prairie species with high Coefficients of Conservatism will probably not be able to maintain themselves. These are usually the most significant plant species present and those that are characteristic of prairie habitat. Species with more exacting microclimate requirements are likely to be replaced with more tolerant and common plant species. Interruption of the natural water cycle in a prairie usually results in a proliferation of shrub species, and the shrubs tend to crowd out the shade-intolerant understory.

Development adjacent to a prairie also has the potential to introduce edge effects to the habitat, e.g., degradation at the edge of the prairie due to introduction of weeds from adjacent developed areas.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of savannah habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The area of the ELC vegetation type is the SWH; there is no minimum size. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the savannah or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on tallgrass prairie habitat will result in loss of the affected habitat, and potential for reduced ecological function of the remaining habitat due to edge effects and succession. The best mitigation option is to avoid developing on the habitat. Where complete avoidance is not possible, and the savannah is large, minimizing the amount and quality of habitat affected may be a satisfactory mitigation. Solar panels and access roads should always be situated in lower quality areas as determined by a tallgrass prairie expert. These will include areas that have been degraded by invasion of non-native plants, woody plants, or native species that are not characteristic of tallgrass prairie habitat. It must be recognized, however, that areas such as these have the potential to become high quality habitat if they are managed by controlled burns. Areas should not be discounted as being poor habitat until some management techniques have been applied.

Prior to development, the minimum area required for construction of the access roads and solar panel arrays should be fenced off and remain fenced until construction is complete. This will prevent heavy equipment from damaging prairie habitat that is to be retained.

The footprint of any access roads that affect tallgrass prairie habitat should be minimized so that as little habitat is destroyed as possible. Sufficient culverts should be installed under access roads to ensure that surface water drainage is not inhibited.

Consider installing power transmission lines under the access road right-of-way to minimize disturbance of retained prairie habitat.

A water balance study should also be completed so that it can be demonstrated that there will be no discernable change in the quantity or quality of water that is directed to the prairie, and that there will be no change in hydro-period. New drainage, for example from driveways, roofs, and parking lots, should never be directed toward the prairie. If these structures are within the existing drainage for the prairie, water should be treated prior to release to the prairie.

Under certain circumstances, it may be possible to create prairie habitat. Ideally, this option would be used to create additional prairie habitat instead of being used as a mitigation measure for replacement of an existing prairie. In order to be successful, suitable soils must be present and this needs to be determined by completing a soil survey. Historical descriptions of vegetation communities completed by the original land surveyors may be useful in determining where prairies historically occurred; these areas will likely have the best potential for prairie restoration. Prior to implementing a prairie restoration project, a management plan needs to be prepared that identifies the plant communities that will be established, the source of the native seeds, and the required management to ensure that the prairie becomes suitably established and is maintained as a high-quality habitat.

Development in lands adjacent to prairie habitat needs to be set back far enough to prevent edge effects.

ROAD DEVELOPMENT

Potential Development Effects

Roads may have both direct and indirect effects on prairies. Direct loss of habitat will occur if a road is built through a prairie. Indirect effects may occur as a result of creation of habitat more conducive to non-native plants or those that are not prairie species, changes in hydrology, and impacts from road de-icing activities.

Typical road construction involves a solid base of sand, gravel, or rock with an upper level of gravel frequently topped by asphalt or concrete. The top of the road is sloped down to the original grade and this slope is typically planted with grasses (mostly non-native species) and the area along the base of the road is often contoured to create ditches to remove surface water from the road and adjacent lands.

The footprint of the road and associated shoulders, banks, and ditches represent a direct loss of habitat. The disturbed nature of the banks and ditches promote colonization by non-native plant species which may also gain a foothold in the adjacent retained prairie habitat.

Depending upon their design, the ditches may result in a change in hydrology to the adjacent prairie. They may carry away water that is essential to the flooding-drought cycle of those prairies on moist-fresh sites or cut-off flow that would normally be directed to the prairie. The roadbed may also act as a hydrological barrier, with higher than normal water levels on one side of the road and lower than normal on the other. Hydrologic changes have the potential to change the composition of prairie plant communities. If the hydrology flooding-drought cycle is interrupted or significantly altered, the prairie species with high Coefficients of Conservatism will probably not be able to maintain themselves. These are usually the most significant plant species present and those that are characteristic of prairie habitat. Species with more exacting microclimate requirements are likely to be replaced with more tolerant and common plant species. Interruption of the natural water cycle in a prairie usually results in a proliferation of shrub species, and the shrubs tend to crowd out the shade-intolerant understory.

Compounds containing salt are typically used to de-ice roads in winter. Airborne salt spray can travel considerable distances depending upon wind velocity and the speed at which vehicles are traveling. Direct contact with salt spray can kill some species, and build-up of salt concentrations within surface and ground water over time may affect a wide variety of other species. Roadsides may also become dominated by halophytic plant species, most of which are non-native.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC vegetation type is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on prairie habitat will result in loss of that portion of the habitat that is under the development footprint. The best mitigation option is to avoid developing in the habitat. Where complete avoidance is not possible, site the road as close to the edge of the prairie as possible. If the road must go through a prairie, direct its route through areas of lesser quality (if these exist) as determined by a tallgrass prairie habitat expert. These will include areas that have been degraded by invasion of non-native plants, woody plants, or native species that are not characteristic of tallgrass prairie habitat.

The construction area should always be fenced off prior to and during construction to ensure that no equipment or heavy machinery enters the part of the prairie that will be retained.

Remove and stockpile all topsoil from the road right-of-way, and use it later to form the banks of the road. This soil will be suitable to support plantings of prairie grasses. Roadsides through prairies should not be planted with the mix of grasses and legumes that is typically used (e.g., agriculture grass and legume mixes). Some of the grasses and legumes in these mixes have the potential to invade the prairie and be detrimental to native plant species. Plant roadsides in or adjacent to prairie habitat with prairie species, preferably using the existing prairie as a seed source.

Minimize the footprint of any road that must be routed through prairie habitat. Design the road for construction as close to the existing grade as possible; this will result in less area being covered by the road and its banks, thereby minimizing the amount of habitat destroyed.

If possible, ditches should not be constructed along the road through the prairie. If ditches are essential, they should be constructed so that they are above the original grade of the prairie instead of excavating into the existing surface. Excavation below the prairie surface has high potential to alter the hydrology. Sufficient culverts need to be installed under the road to allow water to flow unimpeded from one side to the other. If this is done properly and ditches do not remove the water, this should help to maintain the hydrology of the prairie.

No herbicides should be used along the roadside to control vegetation.

Consideration should be given to using de-icing compounds other than salt through prairie habitat.

INDEX #20: SAND BARREN

Ecoregions:	All of Ontario
Species Group:	Sand Barren
Significant Wildlife Habitat Category:	Rare Vegetation Community
Functional Habitat:	Preferred Habitat
Habitat Features:	Exposed sand habitats with little to no soil and protruding rock; vegetation cover varies, but tree cover is always ≤ 60%

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Sand barrens are rare in Ontario, and are thus significant with regard to the protection of representative examples as distinctive natural ecosystems (Carbyn and Catling 1995). Those that remain in the province are very restricted, fragmented and in decline; what little remains is quickly being lost to succession in the absence of fire which served to maintain the open character of the community (COSEWIC 2002).

Sand barren communities are characterized by bare sand substrates that are not associated with distinct topographic features (e.g., sand dunes or shorelines), and are subject to periods of prolonged drought. Vegetation tends to be adapted to low nutrient levels and periodic disturbances such as fire, and ranges from patchy and bare in open sand barrens to more closed in shrub and treed sand barrens (Lee et al. 1998; OMNR 2004).

Only open sand barrens have been documented in Ontario, and tend to occur inland on dry, deep sand deposits (OMNR 2000). Three types of open sand barren are recognized by the Ecological Land Classification System (Lee et al. 1998): dry bracken fern (SBO1-1), dry hay sedge (SBO1-2), and dry slender wheat-grass sand barrens (SBO1-3). Bracken fern sand barrens are listed by the Natural Heritage Information Centre as very rare (S2), and hay sedge and slender wheat-grass sand barrens are both listed as extremely rare (S1) (NHIC 2007). Other vegetation typically present in open sand barrens included deep-green sedge and New Jersey tea. Additionally, mosses and reindeer lichen form a substantial component of the vegetation cover. Vegetation is usually low to the ground, sparse and patchy, and there is much exposed mineral soil. These rare habitats are known to occur in Site Region 6E on the Iroquois Plain (OMNR 2000), the middle and lower Ottawa valley (Carbyn and Catling 1995) and in the lower Trent valley region of eastern Ontario (Catling and Catling 1993), and are listed as a key natural heritage feature of the Oak Ridges Moraine (OMNR 2004).

Wildlife species associated with sand barrens include Five-lined Skink, Eastern Towhee, Whip-poor-will, Common Nighthawk, Eastern Cottontail Rabbit, Snowshoe Hare, Black Bear, Wolf (Pregitzer and Saunders 1999; Mills 2007; Sandilands 2007a; Timpf 2007). Plant associates include Forked Three-awn Grass, Fall Witch Grass, Purple Love Grass, Coast Jointweed and Bird's-foot Violet (OMNR 2000, Appendix G).

There has been a significant reduction in sand barren communities in southern Ontario and southern Quebec over the past 100 years. Losses have resulted from forest succession and concurrent suppression of natural periodic fire, clearing of land for agriculture, large scale establishment of conifer plantations, increasing use of open shoreline areas (old and new) for housing and recreation (including ATVs), and extraction of sand for commercial uses (COSEWIC 2002).

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

The open character of sand barren habitat makes it attractive for residential, cottage and commercial development. Development on sand barren habitat will destroy the habitat. Sand barrens have disappeared as habitat in many parts of Ontario due to residential subdivision and cottage development. The rate of conversion has accelerated in Simcoe County over the past 10 years with increasing population growth, particularly in the communities of Barrie and Wasaga Beach. Estate sprawl is also very common in northern Simcoe County, and Great Lakes shorelines are developing rapidly. Most sand barren habitats in Simcoe County are not protected (COSEWIC 2002). Some human disturbance associated with residential use may be beneficial (e.g., if it prevents forest succession), however the use of ATVs, for example, may prove detrimental to fragile sand barren vegetation.

Development of residential, cottage or commercial properties on lands adjacent to sand barrens may make it more difficult to manage the sand barren habitat. In southern Ontario, wildfires are suppressed to protect property values. Sand barrens are adapted to periodic disturbances such as fire (Lee et al. 1998); the species composition and structure of these communities often change if fire is suppressed (Pregitzer and Saunders 1999). The intensity, size and orientation of the burn affects the characteristics of the habitat, such as the amount of standing dead timber for cavity-nesting species and the amount and patchiness of cover for small mammals. Without disturbance by fire, sand barren communities will not be maintained.

Residential and cottage development adjacent to sand barren habitat may introduce edge effects to the habitat. This may include degradation at the edge of the barren due to introduction of non-native plants from adjacent developed areas and from landowners using it as an area in which to dispose of materials.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC ecosite is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on sand barren habitat will result in loss of that portion of the habitat that is under the development footprint. The best mitigation is to avoid developing in sand barren habitat.

Development on lands adjacent to sand barrens need to be set back sufficiently so that edge effects, such as invasion of non-native species and dumping by landowners, can be avoided.

To mitigate the impacts of fire suppression on sand barrens in developed areas, prescribed burning (by a qualified agency) is an option. However, if the burn cannot adequately mimic a wildfire in extent or patchiness, or in type or degree of vegetation burned, prescribed burns may not provide ideal habitat for certain species

(Pregitzer and Saunders 1999). With extensive exposed sand, most of these areas are not even burnable. The presence of housing or commercial development on or near the sand barren, however, makes it much more difficult to conduct these management actions and often an extensive public education program and public consultation is necessary to conduct a controlled burn. In some cases, concern of the neighbours may be such that a controlled burn is not feasible.

Appropriate management techniques should be implemented to restrict usage of ATVs in sand barrens. This may take the form of fencing, signage, and/or education.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses are the only type of major recreational development that is likely to affect sand barrens. Direct development of sand barrens for fairways, tees, and greens will result in loss of this habitat.

Incorporating sand barren habitat into the active play areas of golf courses, e.g., as sand traps or golf cart pathways, will destroy the feature and its ecological function. If water is directed toward sand barrens, this could affect the local moisture regime and the plant species that are present. Direct flow of water could also result in erosion of sand barren habitat. Fertilizers and pesticides could destroy native sand barren vegetation and promote growth of less sensitive or non-native plant species.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC ecosite is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on sand barren habitat will result in loss of that portion of the habitat that is under the development footprint. The best mitigation is to avoid developing in sand barren habitat.

Design golf courses so that adjacent sand barrens cannot be accessed by players walking between fairways, retrieving balls or driving carts. Plan cart paths where they will not provide pedestrian or vehicular access to adjacent sand barren habitat.

No contour shaping should take place near sand barrens. Changing contours could affect surface water flow patterns and hydrological conditions in sand barrens. This could result in stress to native sand-barren plant species and invasion by non-native species or species with a lower Coefficient of Conservatism. Extreme changes in contours may also cause wind erosion.

No fertilizers or pesticides should be used in the vicinity of sand barrens. Irrigation should not occur nearby as this has the potential to make conditions in the sand barren less suitable for obligate plant species.

Significant sand barren areas that are set aside from development should be turned over to a public agency such as a conservation authority so that agency can undertake the management required (e.g., controlled burning) to maintain the habitat.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Sand extraction for commercial purposes has had an impact over the years on sand barren habitat in Ontario. Sand barren habitat is often utilized as wayside pits for sand extraction, both in southern Ontario and southern Quebec (COSEWIC 2002).

Aggregate development in sand barren habitat will result in loss of the portion of the sand barren that is extracted. Quarry development on adjacent lands also has the potential to alter sand barren communities. Direct loss may occur if berms for visual and noise barriers are constructed on top of sand barren habitat. Sand barren habitat may also be affected if water from the quarry is pumped into it or a pond is created on it, or if the surface water regime is otherwise affected by quarry activities.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC ecosite is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on sand barren habitat will result in loss of the habitat under the footprint of the development. The best mitigation is to avoid developing sand pits in sand barren habitat.

Water from dewatering activities on adjacent lands should not be directed to sand barren habitat if possible. If this is essential, a water budget should be completed so that existing hydro-period conditions can be matched during the extraction period.

ENERGY DEVELOPMENT

Biofuel farms are not considered likely on sand barrens or immediately adjacent to them as the sandy soils associated with this habitat type are generally unsuitable for crop production. There is potential for wind power facilities and solar farms to be developed on or adjacent to sand barrens.

Potential Development Effects: Wind Power Facilities

The open character of sand barren habitat may make it attractive for wind power development. Sand barren habitat will be destroyed where it is covered by turbine pads and access roads. Construction of permanent access roads also has the potential to affect retained sand barren habitat through the introduction of non-native plant species. Additionally, if the road impedes surface water drainage, the hydrologic regime may be altered with subsequent changes in vegetation. Where drainage is not impeded, water may be retained on one side of the road resulting in excessive flooding on that side and insufficient water on the other side.

A wind power development adjacent to sand barren habitat is unlikely to affect the neighbouring barren, unless it changes the habitat's hydrologic regime.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of sand barren habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). This distance is measured from the edge of the ecosite to the tip of the turbine blade when it is rotated toward the habitat (as opposed to from the base of the turbine). The area of the ELC ecosite is the SWH; there is no minimum size. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the sand barren or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Eckhart Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on sand barren habitat will result in loss of that portion of the habitat that is under the development footprint. The best mitigation is to avoid developing wind power facilities in sand barren habitat.

Where wind power development occurs on lands adjacent to sand barren habitat, direct drainage from the site away from the sand barren.

Prior to development, the minimum area required for construction of the access roads and turbine pads should be fenced off and remain fenced until construction is complete. This will prevent heavy equipment from damaging sand barren habitat that is to be retained.

Thought needs to be given to minimizing disturbance to the adjacent sand barren when installing transmission lines from turbines. Localized disturbance and loss of habitat will occur where excavations are made for the installation of poles to carry overhead wiring or trenches for buried wiring. If excavation is essential, the substrate should be restored to a condition similar to pre-construction. Consideration should be given to installing the wiring under the footprint of the access road to minimize the disturbance footprint.

Potential Development Effects: Solar Power Facilities

The open character of sand barren habitat may make it attractive for solar power development. Sand barren habitat will be destroyed where it is covered by solar panels and access roads, and where poles or buried transmission lines are installed. By design, solar panels capture sunlight that would normally reach the habitat. A dramatic reduction in sunlight will have significant impacts on the underlying plant community, likely leading to the loss of barrens species. In addition to physically destroying the habitat, permanent access roads have the potential to affect retained sand barren habitat on either side of them. The disturbance associated with the road may result in a roadside proliferation of non-native plant species. Additionally, if the road impedes surface water drainage, the hydrologic regime may be altered with subsequent changes in vegetation on the barrens. Where drainage is not impeded, water may be retained on one side of the road resulting in excessive flooding on that side and insufficient water on the other side.

A solar power development adjacent to sand barren habitat is unlikely to affect the neighbouring barrens, unless it changes the hydrologic regime.

Mitigation Options: Solar Power Facilities

The siting of solar panels within 120 m of sand barrens habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). This distance is measured from the edge of the ecosite to the edge of the closest solar panel. The area of the ELC ecosite is the SWH; there is no minimum size. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the sand barren or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on sand barrens habitat will result in loss of that portion of the habitat that is under the development footprint. The best mitigation is to avoid developing solar power facilities in sand barrens habitat.

For solar power developments on lands adjacent to sand barren habitat, direct drainage from the site away from the sand barren. Prior to development, the minimum area required for construction of access roads and transmission wire support structures should be fenced off and remain fenced until construction is complete. This will prevent heavy equipment from damaging sand barren habitat that is to be retained.

ROAD DEVELOPMENT

Potential Development Effects

Roads that are built in sand barrens will result in direct loss of the habitat.

Roads adjacent to sand barrens have the potential to have indirect effects. Erosion of sand barrens or delivery of excessive nutrients and sediments to these habitats may occur if water from the road is directed toward sand barrens.

Ditching may interrupt the normal flow of water to a sand barren, and the road may act as a barrier to surface water drainage.

Roads can serve as corridors for the introduction of non-native plant species that may potentially colonize an adjacent sand barren.

Compounds containing salt are typically used to de-ice roads in winter. Airborne salt spray can travel considerable distances depending upon wind velocity and the speed at which vehicles are traveling. Direct contact with salt spray can kill some species, and build-up of salt concentrations within surface and ground water over time may affect a wide variety of other species. Roadsides may also become dominated by halophytic plant species, most of which are non-native.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC ecosite is the SWH; there is no minimum size.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on sand barren habitat will result in loss of that portion of the habitat that is under the development footprint. The best mitigation is to avoid developing roads in sand barren habitat.

The construction area should always be fenced off prior to and during construction to ensure that no equipment or heavy machinery enters the part of the sand barren that will be retained.

If the proposed road is adjacent to a sand barren, it needs to be constructed so that drainage from the road's surface is not directed into the sand barren. There should be sufficient culverts under the road to ensure that the normal surface water drainage is not interrupted.

Consideration should be given to using de-icing compounds other than salt in the vicinity of sand barrens.

INDEX #21: ROCK BARREN, CLIFF AND TALUS SLOPE

Ecoregions:	All of Ontario
Species Group:	Rock Barren, Cliff and Talus Slope
Significant Wildlife Habitat Category:	Rare Vegetation Community
Functional Habitat:	Preferred Habitat

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Rock Barren

Rock barrens were major components of the historic North American landscape before it was extensively altered by agricultural and urban development during the past century. This habitat is now ranked as rare to rare/uncommon in Ontario. Rock outcrop plant communities and rock barrens are of interest because they are refuges for endemic species adapted to extreme environmental conditions. Many of these communities are currently reduced to less than one percent of their original area and are imperiled ecosystems (Anderson et al. 1999). Rock barrens are rare in southern Ontario, and some have been degraded by grazing and quarries.

Rock barrens are open to moderately-treed sites (up to 60% crown coverage) characterised by exposed bedrock and very shallow soils (less than 15 cm) (Lee et al. 1998). Open rock barrens occur where temperature and moisture conditions are most extreme, and are characterized by bare rock surfaces or small patches of very shallow substrates. Vegetation associates include Harebell, Early Saxifrage, Bristle-leaved Sedge, Poverty Grass, Ebony Spleenwort, Cow-wheat, Hairgrass, Prairie Cinquefoil, Fragile Fern, Spikemoss, Rusty Woodsia, Pale Corydalis, Fringed Buckwheat, Hedwig's Moss and Bristly Sarsaparilla. Where conditions are less severe, and where bedrock is cracked and shallow substrates have accumulated, vegetation associates will include Common Juniper, Round-leaved Dogwood, Chokecherry, Blueberry, Red Cedar, Hackberry, Oak, Jack Pine and Pitch Pine.

A number of provincially rare plant species are associated with granite rock barrens including Pitch Pine (found only in Leeds County), Winged Sumac, Small Prickly Pear Cactus, Bear Oak, Case's Ladies' Tresses, Sharp-leaved Goldenrod, Downy Goldenrod and several grasses and sedges (Catling and Brownell 1999; OMNR 2000, Appendix G). Granite barrens also support a diverse fauna, with at least 30 mammal, 136 breeding birds, 10 reptile, 9 amphibian, and 46 butterfly species; key species include Five-lined Skink, a number of butterflies (Olympia Marblewing, Chryxus Arctic, Gray Hairstreak, Dark Crescent), Prairie Warbler, Eastern Towhee, Common Nighthawk, Whip-poor-will and Yellow-billed Cuckoo (Catling and Brownell 1999; Mills 2007; Sandilands 2007a; Timpf 2007; OMNR 2000, Appendix G; Ontario Parks 2005). Mammals include Red Fox, Coyote, and Black Bear that forage on berries and insects found under rocks. Flat rocks in barrens habitats also provide important foraging and cover habitat for many snakes; they may also function as animal movement corridors, especially in areas with numerous wetlands and ponds (OMNR 2000, Appendix G).

With exceptions, the rarity of rock barren habitats in Ontario ranges from extremely rare (S1) to rare/uncommon (S3). The exceptions are considered to be apparently or demonstrably secure, and are extensive throughout the province. These include dry open granite barrens, Blueberry granite shrub barrens, Common Juniper shrub barrens, Jack Pine treed granite barrens and Oak-Red Maple-Pine treed granite barrens (NHIC 2007).

Cliff and Talus Slope

Cliff and talus slope habitats are extremely rare in Ontario; they occur primarily along the Niagara Escarpment, but can also occur elsewhere that sedimentary rock is exposed at the surface such as the limestone plains south of the Canadian Shield (TOARC 2008). Both cliffs and talus are characterized by vegetation cover that varies from patchy and barren to more closed and treed (tree cover up to 60%) (Lee et al. 1998).

Cliffs are defined in the Ecological Land Classification for Southern Ontario as vertical to near vertical exposed bedrock more than 3 m in height (Lee et al. 1998). They are relatively harsh environments, subject to active erosional processes and extremes in moisture and temperature. Depending on the level of moisture and how broken the cliff rim and face are, vegetation associates include Cliffbrake and Bulblet Fern, lichens, Herb Robert, Canada Bluegrass, Common Juniper, Round-leaved Dogwood, White Cedar, Super Maple, Ironwood, White Ash, White Birch and Aspen (Lee et al. 1998). Cliff ledges and crevices provide specialised habitat (hibernacula) for some snakes and bats, hunting and nesting habitat for raptors and other bird species, and denning sites for some mammal species (OMNR 2000, Appendix G).

Talus is defined as a sloping mass of rock fragments at the base of a cliff. Coarse rocky debris, which typically covers over half of the substrate surface, accumulates through the formation and weathering of cliffs. Soils in talus habitat are shallow (less than 15 cm), have little mineral material, and are primarily composed of organic debris (Lee et al. 1998; OMNR 2000). Depending upon moisture regime and substrate availability, vegetation associates include Herb Robert, Poison Ivy, Canada Bluegrass, Maidenhair Spleenwort, Spotted Touch-Me-Not, White Snakeroot, Round-Leaved Dogwood, Mountain Maple, Chinquapin Oak, White Cedar, White Birch, Hemlock, Sugar Maple, Basswood and White Ash. Talus slopes provide specialised habitat (hibernacula) for some snakes (e.g., Black Ratsnake). The accumulated broken rocks at the base of the cliffs frequently provide subterranean entry points for snakes that must hibernate below the frost line. Often these slopes support diverse vegetation communities, particularly if they have a southern exposure, basic soils, and water (OMNR 2000). Other wildlife species associated with talus habitats include Five-lined Skink, Yellow-bellied Flycatcher, Southern Red-backed Vole and Rock Vole (OMNR 2000, Appendix G).

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Rock Barren

Potential Development Effects

Because of the extremely shallow to nonexistent soils, rock barren vegetation is particularly susceptible to disturbance by vehicles and trampling (Ontario Parks 2005). The westernmost barrens region of Georgian Bay and Muskoka include the major recreational area of Ontario, with over 20,000 summer cottages (Catling and Brownell 1999).

In southern Ontario, wildfires are suppressed to protect property values. Rock barrens are adapted to periodic disturbances such as fire (Lee et al. 1998); the species composition and structure of these communities often change if fire is suppressed. The intensity, size and orientation of the burn affects the characteristics of the habitat, such as the amount of standing dead timber for cavity-nesting species and the amount and patchiness of cover for small mammals (Pregitzer and Saunders 1999). Without disturbance by fire, some rock barren communities will not be maintained. In some rock barrens, the absence of soil can prevent establishment of trees, maintaining them in a perpetually open condition, with trees relegated to low-lying depressions on the rock surface where soil may accumulate.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Any rock barren area greater than 1 ha should be considered significant.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Residential and/or commercial development on rock barren habitat will destroy the habitat. The best mitigation option is to avoid developing in the habitat.

Where residential or commercial developments are sited on lands adjacent to rock barren habitat, drainage from the development should always be directed away from the habitat to maintain the plant species compositions unique to the habitat. Stormwater management facilities should never be directed toward these habitats.

To mitigate the impacts of fire suppression, prescribed burning (by a qualified agency) is an option. However, if it cannot adequately mimic a wildfire in extent or patchiness, or in type or degree of vegetation burned, prescribed burns may not provide ideal habitat for certain species (Pregitzer and Saunders 1999). The presence of housing on or near the rock barren, however, makes it much more difficult to conduct these management actions and often an extensive public education program and public consultation is necessary to conduct a controlled burn. In some cases, concern of the neighbours may be such that a controlled burn is not feasible.

Cliff and Talus Slope

Potential Development Effects

The likelihood of residential or commercial development on cliffs and talus slopes is low as these habitats tend to be unstable or too steep to provide suitable building sites.

Developments adjacent to cliff or talus slope habitats have the potential to alter hydrology, and ultimately species composition, if drainage is directed toward the habitats.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on cliff and talus slope habitat will result in destruction of the habitat. The best mitigation is to avoid developing on the habitat. Where residential or commercial developments are sited on lands adjacent to cliffs or talus slopes, drainage from the development should always be directed away from the habitat to maintain the plant species compositions unique to the habitat. Stormwater management facilities should never be directed toward these habitats.

MAJOR RECREATIONAL DEVELOPMENT

Rock Barren

Potential Development Effects

The Georgian Bay and Muskoka barrens regions are very popular for camping and hiking. For example, the Bruce Trail runs the length of the Niagara Escarpment and hiking intensity has risen to 25,000 passes per year. This level of use has resulted in a major change in the vegetation community (Larson et al. 1999, in Anderson et al. 1999).

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Any rock barren area greater than 1 ha should be considered significant.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Rock barrens habitat will be damaged or destroyed where there is high-intensity human use, e.g., hiking and camping. The best mitigation option is to avoid developing on the habitat. Where complete avoidance is not feasible, minimize the amount of habitat affected, e.g., make the development footprint where it affects the habitat as small as possible, and site it as close to the edge of the habitat as possible. An effort should be made to encourage hikers to stay on established trails. Signage and a public education campaign may help people understand the unique characteristics of rock barrens, and the value of leaving them undisturbed.

To mitigate the impacts of fire suppression in areas developed for human use, prescribed burning (by a qualified agency) is an option. However, if it cannot adequately mimic a wildfire in extent or patchiness, or in type or degree of vegetation burned, prescribed burns may not provide ideal habitat for certain species (Pregitzer and Saunders 1999). The presence of structures on or near the rock barren, however, makes it much more difficult to conduct these management actions.

Where recreational facilities are sited on lands adjacent to rock barrens, drainage from the development (e.g., roads, parking lots, campground facilities) should always be directed away from the habitat to maintain the plant species compositions unique to the habitat. Stormwater management facilities should never be directed toward these habitats.

Cliff and Talus Slope

Potential Development Effects

Cliff and talus habitats are vulnerable to major recreational development. In Ontario, some parts of the Niagara Escarpment have been wholly transformed for ski resort construction (Larson et al. 1999, in Anderson et al. 1999).

Cliff and talus habitats also occur in popular hiking areas. For example, the Bruce Trail runs the length of the Niagara Escarpment and hiking intensity has risen to 25,000 passes per year. This level of use has resulted in a major change in the vegetation community (Larson et al. 1999, in Anderson et al. 1999).

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Ski resort development on cliff and talus slope habitat will result in its destruction. The best mitigation is to avoid developing on the habitat.

For hiking trails through areas that include cliff and talus habitat, impacts may be mitigated by routing trails out of visual range of these habitats. Signage and a public education campaign may also help hikers understand the unique characteristics of these habitats, and the value of leaving them undisturbed.

AGGREGATE AND MINE DEVELOPMENT

Rock Barren

Potential Development Effects

Although not currently a common activity, quarrying in granitic rock barren habitats to extract minerals and building materials is likely to increase in the near future as licenses for alvar sites become increasingly difficult to obtain (Mark Browning, pers. comm.). The lack of overburden makes barrens habitats attractive for aggregate development, and emerging technologies are now making the exploitation of granitic rock barrens more feasible than before. Quarrying destroys habitats by physically removing the rock, vegetation and soils that comprise them, and by altering drainage patterns in areas adjacent to the quarry.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Any rock barren area greater than 1 ha should be considered significant.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

The best mitigation is to avoid developing on the habitat. If complete avoidance is not possible, an effort must be made to retain some of the habitat as a subsequent seed source. It may be possible to mitigate some of the negative impacts of developing in the habitat by rehabilitating the quarry prior to closure. Quarrying typically creates new cliff habitat, and often exposes new rock barren surfaces on the floor of the quarry. However, today's blasting techniques tend to leave a very smooth cliff face with no rubble at the base. Rehabilitation includes roughening the cliff face to create benches, cracks, crevices and fissures that will enable rapid colonization of the rock by vegetation and wildlife, and to produce talus at the cliff base (Mark Browning, pers. comm.). Rehabilitation is particularly effective when natural examples of the habitats are nearby, thereby providing a local seed rain to repopulate the restored habitat.

Cliff and Talus Slope

Potential Development Effects

Quarrying into cliff faces and talus slopes destroys these habitats by physically removing the rock, vegetation and substrate that comprise them. Extraction activities adjacent to these habitats has the potential to change hydrologic regimes, and ultimately vegetation communities, in the retained habitat.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Aggregate development on cliff and talus slope habitat will result in destruction of the habitat. The best mitigation is to avoid developing on the habitat. If complete avoidance is not possible, an effort must be made to retain some of the habitat as a subsequent seed source. It may be possible to mitigate some of the negative impacts of developing in the habitat by rehabilitating the cliff face prior to closure. Today's blasting techniques tend to leave a very smooth cliff face with no rubble at the base. Rehabilitation includes roughening the cliff face to create benches, cracks, crevices and fissures that will enable rapid colonization of the rock by vegetation and wildlife, and to produce talus at the cliff base (TOARC 2008). Rehabilitation is particularly effective when natural examples of the habitats are nearby, thereby providing a local seed rain to repopulate the restored habitat.

Additionally, where aggregate extraction occurs adjacent to an undisturbed cliff/talus habitat, consider rehabilitating the newly created cliff face as described above to augment the existing cliff/talus habitat. Additionally, the quarry floor could be rehabilitated to rock barren or alvar habitat (e.g. see about the Quarry-to-Alvar Initiative in Beamer 2007).

ENERGY DEVELOPMENT

Rock Barren

Potential Development Effects: Wind Power Facilities

The construction of turbine pads, access roads and other wind power components on rock barren habitat would physically destroy the habitat.

A wind power development adjacent to rock barren habitat is unlikely to affect the neighbouring rock barren, unless it changes the habitat's hydrologic regime. Changes to the hydrologic regime are likely to result in changes to the vegetation species composition of the habitat.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of rock barren habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). This distance is measured from the edge of the ecosite to the tip of the turbine blade when it is rotated toward the habitat (as opposed to from the base of the turbine). Any rock barren area greater than 1 ha should be considered significant. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the rock barren or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Eckhart Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

The construction of turbine pads, access roads and other wind power components on rock barren habitat would physically destroy the affected habitat. The best mitigation option is to avoid developing in the habitat.

For developments on lands adjacent to rock barrens habitat, a water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the habitat, and that there will be no change in hydro-period. For example, access roads need to be constructed so that runoff is not directed into the habitat. There should be sufficient culverts under the road to ensure that the normal surface water drainage is not interrupted.

Prior to development on adjacent lands, the minimum area required for construction of the access roads and turbine pads should be fenced off and remain fenced until construction is complete. This will prevent heavy equipment from damaging rock barrens habitat that is to be retained.

Potential Development Effects: Solar Power Facilities

The installation of solar panels, and construction of access roads and other project components on rock barren habitat will physically destroy the habitat (vegetation clearing, drilling for panel supports). Even where rock barren vegetation is not cleared, the installation of solar panels in the habitat will result in its loss. By design, solar panels capture sunlight that would normally reach the habitat. A dramatic reduction in sunlight will have significant impacts on the underlying plant community, likely leading to the loss of biomass and structure.

A solar power development adjacent to rock barren habitat is unlikely to affect the neighbouring rock barren, unless it changes the habitat's hydrologic regime. Changes to the hydrologic regime are likely to result in changes to the vegetation species composition of the habitat.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of rock barren habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). Any rock barren area greater than 1 ha should be considered significant. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the rock barren or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

The installation of solar panels, and the construction of access roads and other project components on rock barren habitat will physically destroy the affected habitat. The best mitigation option is to avoid developing in the habitat.

For developments on lands adjacent to rock barrens habitat, a water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the habitat, and that there will be no change in hydro-period. For example, access roads need to be constructed so that runoff is not directed into the habitat. There should be sufficient culverts under the road to ensure that the normal surface water drainage is not interrupted.

Prior to development on adjacent lands, the minimum area required for construction of the access roads and other project components should be fenced off and remain fenced until construction is complete. This will prevent heavy equipment from damaging rock barren habitat that is to be retained.

Cliff and Talus Slope

Potential Development Effects: Wind Power Facilities

The likelihood of wind power development on cliff faces or in talus slope habitat is low as these habitats tend to be unstable or too steep to provide suitable building sites. However, the top margin of cliffs may be attractive for wind power because airflow there can be stronger than the average wind speed. Flow compression occurs when the wind direction is towards the cliff, creating a local increase in wind speed (Larson et al. 2000). The magnitude of these wind-speed effects is determined by the height and length of the cliff; the higher the cliff, the greater the difference in wind speed between the cliff face and the surrounding landscape.

Development of wind power facilities near the margins of cliff habitat has the potential to destroy the cliff face and associated talus slope habitat, particularly when stabilization of the cliff is required to ensure a solid foundation for turbines. Stabilization will also likely lead to changes in the vegetation communities associated with the cliff and talus slope habitat.

Developments adjacent to cliff/talus slope habitats have the potential to alter hydrology, and ultimately species composition, if drainage from turbine pads and access roads is directed toward the habitats.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of cliff or talus slope habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). This distance is measured from the edge of the ecosite to the tip of the turbine blade when it is rotated toward the habitat (as opposed to from the base of the turbine). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Eckhart Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on the margins of cliff habitat has the potential to destroy the cliff face and associated talus slope habitat, particularly when stabilization of the cliff is required to ensure a solid foundation for turbines. Stabilization will also likely lead to changes in the vegetation communities associated with the cliff and talus slope habitat. The best mitigation option is to avoid developing in these areas.

For developments on lands adjacent to cliff/talus slope habitat, including cliff margins, a water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the habitat, and that there will be no change in hydro-period. For example, access roads need to be constructed so that runoff is not directed into the habitat. There should be sufficient culverts under the road to ensure that the normal surface water drainage is not interrupted.

Set the development back far enough from any cliff margin to ensure that construction activities (e.g., blasting and drilling) do not damage the habitat. The minimum area required for construction of the access roads and turbine pads should be fenced off and remain fenced until construction is complete. This will prevent heavy equipment from damaging talus habitat that is to be retained.

Potential Development Effects: Solar Power Facilities

Development near the margins of cliff habitat has the potential to destroy the cliff face and associated talus slope habitat, particularly when stabilization of the cliff is required. Stabilization will also likely lead to changes in the vegetation communities associated with the cliff and talus slope habitat.

Developments adjacent to cliff/talus slope habitats have the potential to alter hydrology, and ultimately species composition, if drainage from solar panels and access roads is directed toward the habitats.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of cliff or talus slope habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

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ROAD DEVELOPMENT

Rock Barren

Potential Development Effects

In difficult terrain, rock surfaces cannot always be avoided in the routing and construction of roadways. Roads constructed on rock barren habitat will result in direct loss of the habitat under the footprint of the road.

Road development adjacent to rock barrens habitat has the potential to have indirect effects. Delivery to these habitats of excessive nutrients and sediments from road runoff may occur if drainage from the road is directed toward the habitat. Additionally, roads can change the hydrology of adjacent lands by interrupting the normal flow of surface water. These impacts could lead to permanent changes in the vegetation communities of these habitats.

Compounds containing salt are typically used to de-ice roads in winter. Airborne salt spray can travel considerable distances depending upon wind velocity and the speed at which vehicles are traveling. Direct contact with salt spray can kill some species, and build-up of salt concentrations within surface and ground water over time may affect a wide variety of other species.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Any rock barren area greater than 1 ha should be considered significant.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development through rock barrens habitat will result in loss of the habitat. The best mitigation is to avoid developing roads through these habitats. If complete avoidance is not possible, the amount of rock barren affected should be minimized. The road should follow the natural contours of the land as much as possible to minimize or avoid blasting and importation of fill. Site the road as close to the edge of the barren as possible.

An effort should also be made to retain at least some of the undisturbed habitat as a subsequent seed source. The construction area should always be fenced off prior to and during construction to ensure that no equipment or heavy machinery enters the part of the habitat that will be retained.

If the proposed road is adjacent to a rock barren, it needs to be constructed so that drainage from the road's surface is not directed into the habitat. There should be sufficient culverts under the road to ensure that the normal surface water drainage is not interrupted.

Consideration should be given to using de-icing compounds other than salt in the vicinity of habitat.

Cliff and Talus Slope

Potential Development Effects

In difficult terrain, rock surfaces cannot always be avoided in the routing and construction of roadways. Modern drilling and blasting techniques and equipment make it feasible to route highways through topography that includes cliff and talus habitat.

Road construction through cliff or talus habitat will result in direct loss of the habitat.

Road development adjacent to cliff/talus habitats has the potential to have indirect effects. Delivery to these habitats of excessive nutrients and sediments from road runoff may occur if drainage from the road is directed toward the habitat. Additionally, roads can change the hydrology of adjacent lands by interrupting the normal flow of surface water. These impacts could lead to permanent changes in the vegetation communities of these habitats.

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An effort should also be made to retain at least some of the undisturbed habitat as a subsequent seed source. The construction area should always be fenced off prior to and during construction to ensure that no equipment or heavy machinery enters the part of the habitat that will be retained.

If the proposed road is adjacent to a cliff/talus habitat, it needs to be constructed so that drainage from the road's surface is not directed into the habitat. There should be sufficient culverts under the road to ensure that the normal surface water drainage is not interrupted.

Consideration should be given to using de-icing compounds other than salt in the vicinity of habitat.

As another mitigation option, consider creating new cliff/talus habitat by rehabilitating any sheer, vertical or nearly vertical surfaces greater than 3 m in height that were formed during construction. Rehabilitation would follow the same guidelines as for aggregate developments, and include roughening the cliff face to create benches, cracks, crevices and fissures that will enable rapid colonization of the rock by vegetation and wildlife, and to produce talus at the cliff base (TOARC 2008). Rehabilitation is particularly effective when natural examples of the habitats are nearby, thereby providing a local seed rain to repopulate the restored habitat.

INDEX #22: BOG AND FEN

Ecoregions:	All of Ontario
Species Group:	Bog and Fen
Significant Wildlife Habitat Category:	Rare Vegetation Community
Functional Habitat:	Preferred Habitat

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Bogs and fens are wetlands that form upon layers of dead and decaying peat. Water in these "peatlands" is at or near the surface. Bogs are nutrient-poor and moderately to highly acidic (pH < 4.2). The substrate is predominantly saturated mosses, chiefly Sphagnum species, ericaceous shrubs, and sedges. Tree cover is typically no more than 25%. Black Spruce is commonly found in many bogs. Tamarack may be present at a lower density and is usually confined to bog edges where more mineralized water is present.

Fens are peatlands characterised by saturated surface layers of poorly to moderately decomposed brown moss or sedge peat, often with well-decomposed peat near the base. The substrate tends to be slightly alkaline to mildly acidic. Sedge species form the dominant vegetation of fens; mosses may be present or absent. Often there are many small and mid-sized shrubs, and sometimes a sparse layer of trees, typically White Cedar and Tamarack. The water and peat in fens are often relatively nutrient rich since they receive water through groundwater discharge (Lee et al. 1998; OMNR 2000).

The Ecological Land Classification System recognizes three types of bogs and three types of fens (Lee et al. 1998): Open Bog (BOO), Shrub Bog (BOS), Treed Bog (ROT), Open Fen (FEO), Shrub Fen (FES) and Treed Fen (FET).

Open bogs are characterized by sparse tree cover (not more than 10%), and up to 25% shrub cover. Ground cover is dominated by saturated Sphagnum peat and sedges (e.g., Few-seeded Sedge, Cotton-grass). In shrub bogs, Sphagnum cover is continuous, and shrub cover is greater than 25%. Tree cover is still sparse at no more than 10%. Treed bogs have tree cover ranging from 10-25% and continuous Sphagnum cover. Vegetation associates include Black Spruce, Tamarack and Leatherleaf. Bogs are extremely species poor, often supporting only 6-7 species. Few-flowered Sedge is an indicator species, as is Sheathed Cotton-grass.

Open fens are characterized by sparse tree cover (not more than 10%), and up to 25% shrub cover. Vegetation associates include Twig-rush, Slender Sedge, Low Sedge, Clubrush, Bog Buckbean and Beaked Sedge. In shrub fen, shrub cover exceeds 25% but tree cover is still sparse (no more than 10%). Key vegetation associates include Sweet Gale, Fen Birch, Shrubby Cinquefoil, Leatherleaf, Velvet-leaf Blueberry, Mountain Holly, Chokeberry, Highbush Blueberry, and low White Cedar. Treed fens have tree cover ranging from 10-25% and are characterized by Tamarack and White Cedar.

Fens and bogs are considered to be rare or specialized wetland communities; they often support rare plant species. Wetland communities are typically rich with wildlife, and bogs and fens are no exception. A variety of salamanders, frogs, turtles, snakes, birds (including area sensitive wetland birds) and mammals (Masked Shrew, several species of vole, southern Bog Lemming, Fisher, Lynx) use southern Ontario's bog and fen habitats (OMNR 2000, Appendix G).

Both fens and bogs are peatlands (Wasyl Bakowsky, pers. comm.). Peat accumulation is a consequence of low decomposition rates caused by water-logged conditions. Deep peat deposits are the result of thousands of years of accumulation of plant debris. Peatlands are unique, acidic ecosystems that support specific plant communities. A number of plant and bird species are found only in peatlands (Quinty and Rochefort 2003).

Potential Development Effects and Mitigation Options

Most bogs and fens in southern Ontario will have been identified as Provincially Significant Wetlands (PSWs). Under the Provincial Policy Statement, development and site alteration is not permitted in PSWs in eco-regions 5E, 6E, or 7E.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Development on/through fens and bogs is challenging because the ongoing decomposition and compression of the organic matter causes settlement and other problems. Residential or commercial development in bog and fen habitat would likely require the site to be drained and/or filled. These activities would result in direct destruction of the habitat. Hydrology would be altered by the draining of bogs and fens, placement of fill and the reduction of storage volume. One of the major effects associated with draining peatlands is carbon loss. Upon exposure to air, peat rapidly oxidizes, decomposes, and releases carbon dioxide to the atmosphere. Additionally, increases in impervious surfaces such as driveways, roads and parking lots may alter groundwater hydrologic regimes over time by increasing runoff.

In addition to obvious wetland drainage/fill actions associated with building on wetlands, increased human presence and changes in hydrology and other physical disturbances in bogs and fens may lead to the introduction of invasive species (e.g., the Mer Bleu bog in eastern Ontario is threatened by Purple Loosestrife (Lythrum salicaria), Glossy Buckthorn (Rhamnus frangula), and European Frog-bit (Hydrocharis morsus-ranae). Bogs and fens are also sensitive to uncontrolled recreational use, such as the use of ATVs and berry-picking.

Residential and/or commercial development on lands adjacent to bogs and fens may have an indirect impact on these habitats. Bogs and fens are extremely sensitive to changes in water levels and nutrient concentrations. Municipal drainage or private drainage/fill in the vicinity of bogs and fens (where it impacts the hydrological system feeding the site) has the potential to negatively affect these rare habitats and the species that reside in/use them. Fens are particularly sensitive to changes in surface water flow and are even more sensitive to changes in groundwater flow.

Any changes in the hydrology of bogs and fens, or in the quality of surface or ground water that they receive, can greatly alter these habitats. Even apparently minor alterations can result in significant changes which may result in the complete destruction of the habitat. These changes may not be evident for a decade or more after disturbance and manifest themselves by loss of obligate bog or fen species and invasion by species that are not typically associated with these wetland types. Open bogs and fens that have had their hydrology changed tend to become shrubby or grow in with trees such as White Birch and Trembling Aspen. Over the long term, the bog or fen may become converted into another wetland type such as thicket or treed swamp or cattail marsh depending upon whether the site became drier or wetter.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Any size bog or fen ELC ecosite identified is SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development in bog and fen habitat that involves draining and/or filling will result in loss of the habitat. The best mitigation is to avoid developing in these habitats. It is important to consider the relative ecological importance of bogs and fens and their species in relation to the total area to be developed. Whenever possible, leave these functional wetlands intact and undisturbed.

For development on lands adjacent to fens and bogs, establish filter/buffer strips that are sufficient in width (based on slope and roughness factors) to prevent sedimentation of the remaining bog/fen. The construction area should be fenced off prior to and during construction to ensure that no equipment or heavy machinery enters the habitat that is to be retained. Construction activities and components (e.g., haul roads, heavy equipment storage and maintenance areas) need to be located outside of the filter strips. To eliminate unnecessary soil disturbance, thought should be given to the most efficient access system to serve the entire development; only the roads that are truly necessary should be constructed.

It is critical that post-development surface and ground water quality and quantity are not altered within the watershed of bogs or fens. Timing of surface and ground water delivery to these wetland types must remain the same otherwise these habitats will be lost or very severely degraded over the long term. Smaller bogs and fens will likely be completely destroyed if the nutrient inputs and water balances are not maintained while very large bogs and fens may retain much of their existing habitat well away from the development but the areas near the development that receive nutrients and water from the development will be altered. Consequently, it is essential that hydrology and hydrogeology studies be undertaken and appropriate mitigation implemented to ensure that there will be no changes in water quality, quantity, or timing of hydro-period.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses represent the major recreational development most likely to affect bog and fen habitat. Marinas also have the potential to affect shoreline fens. Any development within bog and fen habitat will result in the destruction of the wetland.

Golf courses and marinas could also be proposed for construction adjacent to bog and fen habitat. Any golf course or marina that is within the watershed of a bog or fen has high potential to have significant impacts on the wetland and may actually result in the eventual loss of the habitat. Golf course irrigation may change the hydrology of the adjacent wetland habitat and, ultimately, the plant and animal communities there. Over time, the bog/fen may convert into another habitat type. Changes in groundwater quality, e.g., through the introduction of pesticides, herbicides, fertilizers and other pollutants, or the timing of delivery of groundwater will change the characteristics of the vegetation in the habitat.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Any size bog or fen ELC ecosite identified is SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

It is highly unlikely that a golf course or marina can be constructed and operated within the watershed of a bog or fen without causing irreversible damage to these wetland habitats. Certainly, a golf course within the surface drainage area of a bog would alter the wetland. Fens are driven primarily by groundwater, so it is possible that golf course development at a considerable distance from a fen could have impacts on it. It is necessary to understand the groundwater watershed to accurately determine impacts on a fen. Development of a marina in a shoreline fen would destroy the fen.

Where golf courses or marinas are to be developed on lands adjacent to fen and bog habitat, ensure that changes in surface water quality and quantity can be avoided with suitable stormwater management practices. It needs to be demonstrated that the existing timing of surface water delivery will be matched during construction and during operation of the recreational facility.

For fens, a hydrological and hydro-geological study should be undertaken to understand where the source of the groundwater for the fen is and what its underground watershed is. If golf course or marina development is to occur, the proponent must be able to demonstrate that activities associated with recreational development will not affect the groundwater quantity or quality that is flowing into the fen, or the timing of those flows.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

When peat is harvested, the bog essentially becomes unavailable, at least for a period of time, as functional wetland habitat. Peat is harvested for use as a horticultural soil amendment and potting medium, and for use in some septic systems. Peat develops in a bog where decomposing moss has accumulated to a depth of at least 16 inches. Peat accumulates at a rate of about one millimeter per year (Quinty and Rochefort 2003). Commercial peat harvesting involves draining the bog and then mining the peat using a large vacuum harvester or block cutting equipment (Priesnitz 2007). Approximately 99% of Canada's total national production comes from the combined operations of about 20 corporate groups that form the Canadian Sphagnum Peat Moss Association (CSPMA). Collectively, these companies mine about 0.02 percent of the country's 270 million acres of peat bogs, the majority of which are in southern and southeastern Quebec and eastern and northeastern New Brunswick. Current Ontario operations are concentrated in southeastern Ontario (Alfred) and Northwestern Ontario (Fort Frances).

Mazerolle (2003) studied the impacts of peat mining on amphibians in Nova Scotia. He found that amphibian species richness, total amphibian captures of all species combined as well as those of Green Frog were lower in mined bogs than in remnants of bogs that had been mined. Similar negative impacts to plant species (Poulin et al. 1999) and birds (Delage et al. 2000, in Mazerolle 2003) have been reported as a result of peat mining. In contrast, Mazerolle et al. (2001) found that abundance and species richness of small mammal species increased significantly with the percentage of area mined and, in some cases increased with bog area. Disturbance resulting from peat mining appeared to facilitate the invasion of more generalized small-mammal species. There was also no significant impact on species that are typically associated with peatlands such as Southern Bog Lemming and Arctic Shrew.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Any size bog or fen ELC ecosite identified is SWH.

Commercial peat harvesting involves drainage of the peat bog and removal of bog vegetation. As such, peat harvesting results in the direct loss of the bog. Unlike most other types of development, however, peat harvesting does not usually result in an irretrievable loss of wetland habitat. Harvested bogs can be restored (NAWCCC 2001), and restoration is required under Canadian law.

Canadian peat producers have adopted a strict Preservation and Reclamation Policy (CSPMA 2005) that calls for, among other things:

- identifying bogs for preservation through environmental assessment;
- using careful harvesting techniques so that restoration can be readily achieved;
- leaving at least three feet of peat at the bottom of the bog; and
- returning harvested bogs to functioning wetlands.

Canadian government regulations require that bogs be returned to functioning wetlands once extraction is complete. Before beginning, a producer must take all necessary steps to reduce impact on the environment. Records of the flora and fauna present on the bog must be made for restoration purposes, and producers must cooperate with local environmental groups. During harvest, the producer must minimize the acreage being harvested, leave a buffer zone around the bog, leave a layer of peat when harvesting stops, and design drainage ditches so the water table can be restored.

Reclamation options for post-harvested peatlands in Canada include the creation of wetland habitat for waterfowl. These wetland areas, however, are quite different from the original bog ecosystem. Other options for post-harvested sites are as afforestation projects or conversion to agricultural cropland.

Several restoration techniques being developed in Canada aim to return post-harvested peatlands, as much as possible, back to their original state as a functioning wetland. These techniques include re-establishing the hydrological cycle to the site, regenerating/propagating Sphagnum moss, and naturalizing the post-harvest topography of the site (McCue 1999). Methods for rewetting the peat surface and a better understanding of the hydrological and chemical changes associated with harvesting are now being applied to the restoration of post-harvested peatlands. A functioning peatland, which is a self-sustaining ecosystem, will accumulate carbon, regulate water flow, support a variety of habitats and species, and provide recreational activities. However, paleo-archives (samples that contain a biotic and climatic history of the peatland) will be lost forever unless peat cores are taken prior to peat extraction (Quinty and Rochefort 2003). As with many reclamation and restoration programs, successful plant re-colonization may take long periods of time.

Whether true peat bog restoration is in fact possible is a matter for debate. Some wetland experts say that since a peat bog takes thousands of years to evolve, once destroyed it can never be fully reclaimed (Priesnitz 2007). When the peat is removed, the underlying soil is often too rich in nutrients for habitat restoration (McCue 1999). The NAWCCC (2001) estimates that harvested peatlands can be restored to "ecologically balanced systems" – if not peat bogs – within five to 20 years after peat harvesting.

ENERGY DEVELOPMENT

Potential Development Effects: Biofuel Farms

The draining and subsequent conversion of bog and fen habitat to farmland for the production of crops for ethanol (e.g., biomass feedstock such as corn and soy) will destroy these wetland habitats, resulting in the release of carbon and contributing to climate change.

Irrigation and drainage of agricultural fields adjacent to bog and fen habitat may disrupt the hydrologic regime of the wetland. The application of herbicides, pesticides and fertilizers to biofuel crops may degrade the quality of the water that enters adjacent fen and bog habitat. Changes in the water quantity and quality may lead to altered plant and animal communities in adjacent wetlands.

Mitigation Options: Biofuel Farms

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Any size bog or fen ELC ecosite identified is SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Drainage and cultivation of bog and fen habitat for biofuel crops will result in loss of the habitat. The best mitigation is to avoid developing biofuel farms in wetland habitat. It is important to consider the relative ecological importance of bogs and fens and their species in relation to the total area to be developed. Whenever possible, leave these functional wetlands intact and undisturbed. When development is occurring adjacent to fens and bogs, establish filter/buffer strips that are sufficient in width (based on slope and roughness factors), and on which machine access is controlled, to prevent sedimentation of the remaining bog/fen.

It is highly unlikely that a biofuel farm can be constructed and operated within the watershed of a bog or fen without causing irreversible damage to these wetland habitats. Certainly, a biofuel farm within the surface drainage area of a bog would alter the wetland. Fens are driven primarily by groundwater, so it is possible that biofuel crops at a considerable distance from a fen could have impacts on it. It is necessary to understand the groundwater watershed to accurately determine impacts on a fen.

Where biofuel farms are to be developed on lands adjacent to fen and bog habitat, ensure that changes in the quality and quantity of surface water reaching the wetland can be avoided with suitable drainage practices. It also needs to be demonstrated that the timing of surface water delivery to the wetland will not be changed by the development.

For fens, a hydrological and hydro-geological study should be undertaken to understand where the source of the groundwater for the fen is and what its underground watershed is. If biofuel crop development is to occur, a water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the wetland, and that there will be no change in hydro-period. Drainage from fields of crops should not be directed toward adjacent bog and fen habitat. If the farm is within the existing drainage for the bog/fen, water should be treated prior to release to the environment.

Potential Development Effects: Wind Power Facilities

Creating stable building sites for turbines, access roads and other components of a wind power facility in bog and fen habitat would require the wetland to be drained and/or filled. These activities will result in direct destruction of the habitat. Hydrology will be altered by the drainage, and by placement of fill, and the reduction of storage volume. Changes in hydrology and other physical disturbances may lead to the introduction of invasive species. For example, the Mer Bleu bog in eastern Ontario is threatened by Purple Loosestrife (Lythrum salicaria), Glossy Buckthorn (Rhamnus frangula), and European Frog-bit (Hydrocharis morsus-ranae). Additionally, increases in impervious surfaces such as turbine pads and access roads, will increase runoff which may alter groundwater hydrologic regimes over time.

For peatlands, another effect associated with drainage is the release of carbon to the atmosphere. Upon exposure to air, peat rapidly oxidizes, decomposes, and releases carbon.

Wind power facilities developed on lands adjacent to bog and fen habitat may have an indirect impact on these habitats. Bogs and fens are extremely sensitive to changes in water levels and nutrient concentrations. Drainage from pads and access roads (where it impacts the hydrological system feeding the wetland) has the potential to negatively affect these rare habitats and the species that reside in/use them. Fens are particularly sensitive to changes in surface water flow and are even more sensitive to changes in groundwater flow.

Any changes in the hydrology of bogs and fens, or in the quality of surface or ground water that they receive, can greatly alter these habitats. Even apparently minor alterations can result in significant changes which may result in the complete destruction of the habitat. These changes may not be evident for a decade or more after disturbance and manifest themselves by loss of obligate bog or fen species and invasion by species that are not typically associated with these wetland types. Open bogs and fens that have had their hydrology changed tend to become shrubby or grow in with trees such as White Birch and Trembling Aspen. Over the long term, the bog or fen may become converted into another wetland type such as thicket or treed swamp or cattail marsh depending upon whether the site became drier or wetter.

Mitigation Options: Wind Power Facilities

No renewable energy project may be developed within or expanded into a bog or fen in a provincially significant southern or coastal wetland (Ontario Regulation 359/09:37.1 and 37.2). The siting of wind turbines within 120 m of the outer edge of bog and fen habitat in a provincially significant northern wetland or elsewhere should be avoided. This distance is measured from the edge of the ecosite to the tip of the turbine blade when it is rotated toward the habitat (as opposed to from the base of the turbine). Any size bog or fen ELC ecosite identified is SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Eckhart Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development in bog and fen habitat that involves draining and/or filling will result in loss of the habitat. The best mitigation is to avoid developing in these habitats. It is important to consider the relative ecological importance of bogs and fens and their species in relation to the total area to be developed. Whenever possible, leave these functional wetlands intact and undisturbed.

For development on lands adjacent to fens and bogs, a water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the habitat, and that there will be no change in hydro-period. For example, access roads need to be constructed so that runoff is not directed into the habitat. There should be sufficient culverts under the road to ensure that the normal surface water drainage is not interrupted.

Establish filter/buffer strips between the development and the adjacent habitat that are sufficiently wide (based on slope and roughness factors) to prevent sedimentation of the remaining bog/fen. The construction area should be fenced off prior to and during construction to ensure that no equipment or heavy machinery enters the habitat that is to be retained. Construction activities and components (e.g., haul roads, heavy equipment storage and maintenance areas) need to be located outside of the filter strips.

It is critical that post-development surface and ground water quality and quantity are not altered within the watershed of bogs or fens. Timing of surface and ground water delivery to these wetland types must remain the same otherwise these habitats will be lost or very severely degraded over the long term. Smaller bogs and fens will likely be completely destroyed if the nutrient inputs and water balances are not maintained while very large bogs and fens may retain much of their existing habitat well away from the development but the areas near the development that receive nutrients and water from the development will be altered. Consequently, it is essential that hydrology and hydrogeology studies be undertaken and appropriate mitigation implemented to ensure that there will be no changes in water quality, quantity, or timing of hydro-period.

Potential Development Effects: Solar Power Facilities

Creating stable building sites for solar panels, access roads and other components of a solar power facility in bog and fen habitat would require the wetland to be drained and/or filled. These activities will result in direct destruction of the habitat. Hydrology will be altered by the drainage, and by placement of fill, and the reduction of storage volume. Changes in hydrology and other physical disturbances may lead to the introduction of invasive species (e.g., the Mer Bleu bog in eastern Ontario is threatened by Purple Loosestrife (Lythrum salicaria), Glossy Buckthorn (Rhamnus frangula), and European Frog-bit (Hydrocharis morsus-ranae). Additionally, increases in impervious surfaces such as solar panels, access roads and maintenance structures, will increase runoff which may alter groundwater hydrologic regimes over time.

Draining peatlands also results in carbon loss. Upon exposure to air, peat rapidly oxidizes, decomposes, and releases carbon dioxide to the atmosphere.

Increased human presence (construction, maintenance), changes in hydrology, and physical disturbances in bogs and fens may lead to the introduction of invasive species. For example, the Mer Bleu bog in eastern Ontario is threatened by Purple Loosestrife (Lythrum salicaria), Glossy Buckthorn (Rhamnus frangula), and European Frog-bit (Hydrocharis morsus-ranae).

Development on lands adjacent to bogs and fens may have an indirect impact on these habitats. Bogs and fens are extremely sensitive to changes in water levels and nutrient concentrations. Runoff from the development has the potential to negatively affect these rare habitats and the species that reside in/use them. Fens are particularly sensitive to changes in surface water flow and are even more sensitive to changes in groundwater flow.

Any changes in the hydrology of bogs and fens, or in the quality of surface or ground water that they receive, can greatly alter these habitats. Even apparently minor alterations can result in significant changes which may result in the complete destruction of the habitat. These changes may not be evident for a decade or more after disturbance and manifest themselves by loss of obligate bog or fen species and invasion by species that are not typically associated with these wetland types. Open bogs and fens that have had their hydrology changed tend to become shrubby or grow in with trees such as White Birch and Trembling Aspen. Over the long term, the bog or fen may become converted into another wetland type such as thicket or treed swamp or cattail marsh depending upon whether the site became drier or wetter.

Mitigation Options: Solar Power Facilities

No renewable energy project may be developed within or expanded into a bog or fen in a provincially significant southern or coastal wetland (Ontario Regulation 359/09:37.1 and 37.2). The siting of solar panel arrays within 120 m of the outer edge of bog and fen habitat in a provincially significant northern wetland or elsewhere should be avoided. Any size bog or fen ELC ecosite identified is SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development in bog and fen habitat that involves draining and/or filling will result in loss of the habitat. The best mitigation is to avoid developing in these habitats. It is important to consider the relative ecological importance of bogs and fens and their species in relation to the total area to be developed. Whenever possible, leave these functional wetlands intact and undisturbed.

For development on lands adjacent to fens and bogs, establish filter/buffer strips that are sufficient in width (based on slope and roughness factors) to prevent sedimentation of the remaining bog/fen. The construction area should be fenced off prior to and during construction to ensure that no equipment or heavy machinery enters the habitat that is to be retained. Construction activities and components (e.g., haul roads, heavy equipment storage and maintenance areas) need to be located outside of the filter strips. To eliminate unnecessary soil disturbance, thought should be given to the most efficient access system to serve the entire development; only the roads that are truly necessary should be constructed.

It is critical that post-development surface and ground water quality and quantity are not altered within the watershed of bogs or fens. Timing of surface and ground water delivery to these wetland types must remain the same otherwise these habitats will be lost or very severely degraded over the long term. Smaller bogs and fens will likely be completely destroyed if the nutrient inputs and water balances are not maintained while very large bogs and fens may retain much of their existing habitat well away from the development but the areas near the development that receive nutrients and water from the development will be altered. Consequently, it is essential that hydrology and hydrogeology studies be undertaken and appropriate mitigation implemented to ensure that there will be no changes in water quality, quantity, or timing of hydro-period.

Prior to development on adjacent lands, the minimum area required for construction of the access roads and other project components should be fenced off and remain fenced until construction is complete. This will prevent heavy equipment from damaging habitat that is to be retained.

ROAD DEVELOPMENT

Potential Development Effects

Roads cannot be constructed through bogs or fens without significant direct and indirect impacts. The footprint of the road is a direct habitat loss. The indirect effects are more insidious and may have even greater impacts.

Roads built through these wetland types tend to have a poor foundation and consequently have to be built up and reconstructed at intervals. The road base acts as a barrier to groundwater and surface water flow and this can only be partially rectified by installation of numerous culverts. The result is that one side of the road becomes wetter and the other drier. On the wetter side, bog and fen vegetation becomes replaced with marsh vegetation, usually cattails. On the drier side, the vegetation becomes shrubbier to the detriment of bog and fen species.

Because roads in these wetland types are continuously subsiding, ditches are typically dug on both sides of the road. The ditches intercept shallow groundwater flow and typically remove it from the watershed of the bog or fen. This can result in widespread drying of the wetland community and conversion from bog or fen habitat to another vegetation type.

Roads also change the hydrology and nutrient regime of bogs and fens by introducing water that runs directly off the road along with sediments and nutrients. These changes also promote conversion of the bog or fen to another vegetation community type.

Compounds containing salt are typically used to de-ice roads in winter. Airborne salt spray can travel considerable distances depending upon wind velocity and the speed at which vehicles are traveling. Direct contact with salt spray can kill some species, and build-up of salt concentrations within surface and ground water over time may affect a wide variety of other species.

Roads that are outside of bogs or fens but within their watersheds may also have significant effects. If road runoff, sediments, and nutrients flow into these wetland types, the bog and fen vegetation will be adversely affected. If roadside ditches intercept groundwater, there will be radical changes in the vegetation communities of the bog or fen.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Any size bog or fen ELC ecosite identified is SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Road construction in or through bog and fen habitat will result in its destruction. In small bogs and fens, a road will result in the eventual demise of these wetland habitats and conversion to another vegetation type. In larger bogs and fens, the impacts will be evident for a considerable distance on either side of the road. The best mitigation option is to avoid developing in the habitat. Where complete avoidance is not possible, and the wetland is large, site the road as close to the edge of the habitat as possible. Minimize the footprint of the road and use permeable fill such as coarse rock for the base. Install sufficient culverts to allow free passage of surface water. These mitigation measures, however, may not be very effective and may just slow the pace at which bog and fen vegetation becomes replaced.

Consideration should be given to using de-icing compounds other than salt in the vicinity of habitat.

For roads proposed for construction on lands adjacent to bog and fen habitat, the best mitigation is to site the road outside the watershed of the wetland in question. Where this is not possible, stormwater management facilities need to be constructed so that road runoff does not flow into the wetland. The amount of surface water that reaches the wetland needs to remain unchanged and be of the same quality as prior to construction of the road.

Hydro-geological studies should be undertaken to determine if the roadbed or ditches will intercept groundwater flow to the wetland. If this is likely to occur, no roadside ditches should be constructed. A hydro-geologist should determine the best means of ensuring that groundwater flow continues through the base of the road. This may require using a permeable base such as coarse rocks or gravel that will not inhibit groundwater flow.

INDEX #23: OLD-GROWTH FOREST

Ecoregions:	All of Ontario
Species Group:	Old-Growth Forest
Significant Wildlife Habitat Category:	Rare Vegetation Community
Functional Habitat:	Preferred Habitat
Habitat Features:	Relatively undisturbed, structurally complex; dominant tree species > 100 years old

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Most of southern Ontario's old-growth forests were destroyed by logging, forest fires and settlement between the mid-1700s and the early 1900s. Today, old-growth forest is rare in eco-regions 5E, 6E and 7E with only a few stands remaining in southern Ontario (e.g., in Algonquin Park or Peter's Woods in Northumberland County).

Although definitions of old-growth forest vary depending on tree species, generally these sites are characterised by having numerous trees greater than 140 years old. Other features include:

- a broad array of fallen logs in various sizes and stages of decomposition;
- at least some very large fallen logs;
- large spectrum of tree sizes, including some very tall trees and cavity trees;
- some larger trees with more columnar form due to loss of large limbs from past storm damage;
- numerous mast trees and shrubs that provide food for wildlife;
- numerous snags;
- some pit and mound ground topography; and
- uneven canopy with scattered gaps due to fallen trees and tree limbs.

The best stands are those that exhibit the greatest number of old growth characteristics.

Old-growth forests tend to be relatively undisturbed, structurally complex, and contain a wide variety of trees and shrubs in various age classes. These habitats usually support a high diversity of wildlife species. For example, Northern Goshawks are most commonly found in large, dense stands of mature or old growth forests. They nest in both deciduous and coniferous trees. Bald Eagles nest in mature or old-growth forest with discontinuous or open canopy, usually where there is 20 to 50% crown coverage (Gerrard et al. 1975; Haywood and Ohmart 1983; Peterson 1986). The Pileated Woodpecker is representative of mature and old growth forest habitat in the Great Lakes-St. Lawrence Forest (OMNR 2000, Appendix R). Brown Creeper appears to be an old-growth obligate species that may need at least 3 ha of old-growth around the nest site (Campbell et al. 1997; Haney 1999; Hejl et al. 2002a; Higgelke and MacLeod 2000; Wiggins 2005). Winter Wren is typically associated with old-growth forest (Barrows 1986; Haney 1999; Cumming and Diamond 2002; Hejl et al. 2002b; Sinclair et al. 2003), nesting mostly in coniferous and mixed stands. The Barred Owl uses mature deciduous and mixed forests, with dead or decadent cavity trees for nesting (Peck and James 1983), and is an indicator species for old-growth forest (Mazur and James 2000).

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Tree removal for the creation of building sites, roads and parking lots, and the removal of trees considered hazardous to humans (e.g., very old, diseased or dead trees), results in loss of forest density and simplifies the structure of the habitat. Removal of old trees will have direct effects on wildlife species that require large, old trees and cavities. These include some raptors and a wide variety of cavity-nesting birds and mammals.

Removal of large snags and downed logs results in the removal of microhabitats that are important for a variety of wildlife species. These features may support nesting Turkey Vultures, Winter Wrens, and a large suite of wildlife species.

Opening of the forest and removal of even portions of old-growth forest may have impacts on adjacent remaining old-growth forest. This may create edge effects such as growth of shrubs and saplings as well as resulting in invasion by non-native plant species into the forest. This may lessen the habitat value for species that are dependent upon old-growth forest habitat such as raptors that hunt under the forest canopy. Native plant species may be displaced by non-native species.

Where the planned development will affect a younger forest that borders old-growth forest, clearing of the younger forest will likely introduce edge effects to the retained old-growth forest. Edge effects include shrub and sapling growth, and invasion of the old-growth forest by non-native plant species.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Any size of old growth forest ELC ecosite identified is SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Residential and/or commercial development in old growth forest will result in the physical destruction of the habitat where clearing occurs, and potential loss of function in adjacent retained old-growth forest. The best mitigation option is to avoid developing in the habitat. There is essentially no mitigation that can be undertaken that will replace old-growth forest.

Where development is planned within a younger forest that borders old-growth forest, the younger forest should not be cleared to the edge of the old-growth forest. Leaving a suitable buffer of existing forest along the edge of old-growth forest will protect the rooting zone of the old growth and prevent an edge effect from occurring (e.g., shrub and sapling growth, invasion by non-native plant species). This buffer should be allowed to grow, regenerate and die without disturbance. Snags and woody debris should not be removed to “tidy up” the forest.

If a residential or commercial development adjacent to old-growth forest includes the establishment of trails, these should be carefully planned to avoid old growth as much as possible. Trampling will destroy sensitive understory vegetation, and the high density of snags and hazard trees may present a safety concern. Where trails encroach on old-growth forest, they need to be routed away from existing snags and hazard trees, and provide boardwalks and bridges over damp areas and sensitive species. When trees fall over the trail, only the portion of the tree that is blocking the trail should be removed so that the remainder of the log can be used as plant and wildlife habitat. Interpretive signs should be installed so that trail users are aware of the significance of the habitat and the features within it, and that wandering from the trail is not permitted.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Old-growth forest is most likely to be affected by ski resorts, but golf courses also have the potential to affect this habitat type. There is some limited potential for marina development at the edge of old-growth forest.

Ski runs have the potential to cut through old-growth forest, particularly on slopes where soil depths are very shallow or almost non-existent. In these areas, the trees present may not be very large but can potentially be very old due to the difficult growing conditions. Ski runs that go directly through old-growth forest will result in direct loss of habitat where clearing occurs and a potential loss of function in adjacent retained old-growth forest.

Cutting through old-growth forest or through forest immediately adjacent to old-growth forest for golf course fairways or marina development will have impacts similar to those described above for ski runs.

Opening of the forest and removal of even portions of old-growth forest may have impacts on adjacent remaining old-growth forest. This may create edge effects such as growth of shrubs and saplings as well as resulting in invasion by non-native plant species into the forest. This may lessen the habitat value for species that are dependent upon old-growth forest habitat such as raptors that hunt under the forest canopy. Native plant species may be displaced by non-native species.

Where the planned development will affect a younger forest that borders old-growth forest, clearing of the younger forest will likely introduce edge effects to the retained old-growth forest.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Any size of old growth forest ELC ecosite identified is SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Major recreational development in old growth forest will result in the physical destruction of the habitat where clearing occurs, and potential loss of function in adjacent retained old-growth forest. The best mitigation option is to avoid developing in the habitat. There is essentially no mitigation that can be undertaken that will replace old-growth forest.

Where the planned development will involve clearing in a younger forest that borders old-growth forest, the younger forest should not be cleared to the edge of the old-growth forest. Leaving a suitable buffer of existing forest along the edge of old-growth forest will protect the rooting zone of the old growth and prevent an edge effect from occurring (e.g., shrub and sapling growth, invasion by non-native plant species). This buffer should be allowed to grow, regenerate and die without disturbance. Snags and woody debris should not be removed to "tidy up" the forest.

Design golf courses so that adjacent old growth cannot be accessed by players walking between fairways, retrieving balls or driving carts. Plan cart paths where they will not provide pedestrian or vehicular access to adjacent old-growth forest. Where complete avoidance is not possible, ensure that cart paths provide boardwalks and bridges to span sensitive areas.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Old-growth forest is more likely to be affected by mine development than by pit and quarry development. Areas suitable for pits and quarries tend to have very shallow soils and support cultural communities, alvars, or second-growth forests.

Mine development has the potential to affect old-growth forest through direct removal of habitat, coverage with tailings, and by creating edge effects by removing adjacent forest vegetation.

Removal of portions of old-growth forest may result in impairment of function of the residual forest. This may occur through fragmentation of the forest so that it supports fewer species and creation of edge effects in the remaining old-growth forest. Edge effects may include invasion by non-native plant species and growth of shrubs and saplings along the new edge.

Where the planned development will affect a younger forest that borders old-growth forest, clearing of the younger forest will likely introduce edge effects to the retained old-growth forest.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Any size of old growth forest ELC ecosite identified is SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Mine development in old growth forest will result in the physical destruction of the habitat where clearing occurs, and potential loss of function in adjacent retained old-growth forest. The best mitigation option is to avoid developing in the habitat. There is essentially no mitigation that can be undertaken that will replace old-growth forest.

Where the planned development will involve clearing in a younger forest that borders old-growth forest, the younger forest should not be cleared to the edge of the old-growth forest. Leaving a suitable buffer of existing forest along the edge of old-growth forest will protect the rooting zone of the old growth and prevent an edge effect from occurring (e.g., shrub and sapling growth, invasion by non-native plant species). This buffer should be allowed to grow, regenerate and die without disturbance. Snags and woody debris should not be removed to "tidy up" the forest.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Clearing for the development of turbine pads, access roads and other components of a wind energy development in old-growth forest represents a direct loss of old-growth forest. Additionally, the introduction of access roads has the potential to affect old-growth habitat on either side through the creation of edge effects, e.g., growth of shrubs and saplings, invasion by non-native plant species.

Removal of even portions of old-growth forest may have impacts on adjacent remaining old-growth forest. This may create edge effects and reduce the habitat value for species that are dependent upon old-growth forest habitat such as raptors that hunt under the forest canopy. Native plant species may be displaced by non-native species.

Where the planned development will affect a younger forest that borders old-growth forest, clearing of the younger forest will likely introduce edge effects to the retained old-growth forest.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of old-growth forest habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). This distance is measured from the edge of the ecosite to the tip of the turbine blade when it is rotated toward the habitat (as opposed to from the base of the turbine). Any size of old growth forest ELC ecosite identified is SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Eckhart Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Wind power development in old growth forest will result in the physical destruction of the habitat where clearing occurs, and potential loss of function in adjacent retained old-growth forest. The best mitigation option is to avoid developing in the habitat. There is essentially no mitigation that can be undertaken that will replace old-growth forest.

Where the planned development will involve clearing in a younger forest that borders old-growth forest, the younger forest should not be cleared to the edge of the old-growth forest. Leaving a suitable buffer of existing forest along the edge of old-growth forest will protect the rooting zone of the old growth and prevent an edge effect from occurring (e.g., shrub and sapling growth, invasion by non-native plant species). This buffer should be allowed to grow, regenerate and die without disturbance. Snags and woody debris should not be removed to "tidy up" the forest.

Potential Development Effects: Solar Power Facilities

Vegetation clearing in old-growth forest habitat for development will destroy the affected habitat.

Opening of the forest and removal of even portions of old-growth forest may have impacts on adjacent remaining old-growth forest. This may create edge effects such as growth of shrubs and saplings as well as resulting in invasion by non-native plant species into the forest. This may lessen the habitat value for species that are dependent upon old-growth forest habitat such as raptors that hunt under the forest canopy. Native plant species may be displaced by non-native species.

Where the planned development will affect a younger forest that borders old-growth forest, clearing of the younger forest will likely introduce edge effects to the retained old-growth forest. Edge effects include shrub and sapling growth, and invasion of the old-growth forest by non-native plant species.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of old-growth forest habitat should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). Any size of old growth forest ELC ecosite identified is SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing in old-growth forest for development will result in loss of the affected habitat, and the potential for loss of ecological function in adjacent retained old-growth forest. The best mitigation option is to avoid developing in the habitat. There is essentially no mitigation that can be undertaken that will replace old-growth forest.

Where development is planned within a younger forest that borders old-growth forest, the younger forest should not be cleared to the edge of the old-growth forest. Leaving a suitable buffer of existing forest along the edge of old-growth forest will protect the rooting zone of the old growth and prevent an edge effect from occurring (e.g., shrub and sapling growth, invasion by non-native plant species). This buffer should be allowed to grow, regenerate and die without disturbance. Snags and woody debris should not be removed to "tidy up" the forest.

Prior to development on adjacent lands, the minimum area required for construction of the access roads and other project components should be fenced off and remain fenced until construction is complete. This will prevent heavy equipment from damaging habitat that is to be retained.

ROAD DEVELOPMENT

Potential Development Effects

Clearing for the construction of roads in or through old-growth forest represents a direct loss of old-growth forest habitat. The loss of even portions of old-growth forest may have negative impacts on the rest of the stand. Removal of old-growth components reduces forest density, simplifies the structure of the habitat, and may lead to loss of habitat function. For example, removal of old trees will have direct effects on wildlife species that require large, old trees and cavities. These include some raptors and a wide variety of cavity-nesting birds and mammals. Removal of large snags and downed logs results in the removal of microhabitats that are important for a variety of wildlife species. These features may support nesting Turkey Vultures, Winter Wrens, and a large suite of wildlife species.

Clearing for the development of roadway corridors will create new edges in the forest, which can lead to edge effects such as shrub and sapling growth and invasion of the old-growth forest by non-native plant species. Native plant species may be displaced by non-native species.

Where the planned development will affect a younger forest that borders old-growth forest, clearing of the younger forest will likely introduce edge effects to the retained old-growth forest.

Compounds containing salt are typically used to de-ice roads in winter. Airborne salt spray can travel considerable distances depending upon wind velocity and the speed at which vehicles are traveling. Direct contact with salt spray can kill some species, and build-up of salt concentrations within surface and ground water over time may affect a wide variety of other species.

The construction of roads, including resource roads, through old-growth forest bisects the habitat and creates crossing hazards for wildlife.

Roads may also alter the water regime and introduce contaminants into the habitat.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Any size of old growth forest ELC ecosite identified is SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for road construction through old-growth forest represents a direct loss of old-growth forest habitat. The best mitigation option is to avoid developing in the habitat. Where complete avoidance is not possible, the footprint of the road and its banks should be minimized and it should be routed along an edge instead of through the interior of the old-growth stand. The road should be designed to follow the contours of the landscape as much as possible to reduce the amount of fill required. These choices will minimize the amount of old-growth forest that is directly lost and mitigate effects on the rest of the stand. Where possible, retain the tree canopy over the roadway to minimize the impacts of forest fragmentation on breeding bird populations.

Sufficient culverts should be installed under the road to ensure free movement of surface water and shallow groundwater. This will help maintain the hydrologic regime within the forest.

If surface runoff and potential introduction of contaminants into the forest are a concern, appropriate stormwater management facilities should be built and maintained. Consideration should be given to using de-icing compounds other than salt in the vicinity of habitat.

The roadsides should always be planted with native plant species and spraying of herbicides should never occur along the road through or adjacent to the old-growth forest.

Prior to development, the minimum area required for construction of the road should be fenced off and remain fenced until construction is complete. This will prevent heavy equipment from damaging old-growth forest habitat that is to be retained.

RARE OR SPECIALIZED HABITAT

INDEX #24: AQUATIC FEEDING HABITAT FOR MOOSE

Ecoregions:	3E, 5E
Species Group:	Moose
Significant Wildlife Habitat Category:	Rare or Specialized Habitats
Functional Habitat:	Aquatic Feeding Area
Habitat Features:	Wetlands or isolated embayment in rivers or lakes with an abundance of submerged aquatics; adjacent stands of lowland conifer or mixed woods

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

From June through July, moose consume large quantities of aquatic plants. Their selection of aquatic plants is linked to a need for sodium since these plants have relatively high concentrations of this essential element (Fraser and Reardon 1980; Fraser et al. 1980; OMNR 1988; Thompson and Euler 1988). Moose require sodium at this time of year for antler development and lactation, as well as basic neurophysiological functions. During spring and summer, moose consume terrestrial plants which are much higher in potassium than sodium. This dietary imbalance in the ratio of potassium to sodium ingested results in flushing of sodium from the body. As a result moose develop considerable "thirst" for salt which they satisfy with a diet of aquatic plants (Fraser et al. 1982). MacCracken et al. (1993), however, felt that aquatic feeding was not related to sodium hunger, as terrestrial plants also offered high sodium levels. They hypothesized that aquatic feeding was more efficient because the aquatic plants in ponds produced four times more forage than terrestrial habitat, and aquatic plants were more digestible.

Moose may move considerable distances to reach preferred feeding sites (as far as 30 km) (Fraser et al. 1980; Thompson and Euler 1988). They feed several times a day for about an hour at a time. Submergent vegetation is used more frequently than emergent aquatic plants. Moose select species with the highest sodium concentration.

For an area to function as an aquatic feeding area it must have an abundance of preferred aquatic plants located in an undisturbed site with nearby forest habitat providing shade and hiding cover. Pondweeds, Yellow Water-lily, and Water-milfoil are preferred species but moose will use a variety of plants (Jordan et al. 1973; Fraser et al. 1980, 1982). Moose use areas of lowland conifer located near aquatic feeding areas during the warmest part of the day to reduce the effects of heat stress. An ideal arrangement is to have areas of abundant submergent aquatic plants adjacent to stands of lowland conifers (Kearney and Gilbert 1976; Joyal and Scherrer 1978; Brusnyk and Gilbert 1983). Aquatic feeding areas include both the nearshore area providing plant material and the adjacent forest cover.

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Development has the greatest potential to disrupt the function of a site as an aquatic feeding area if it involves shoreline site alteration (e.g., waterfront residential and cottage) and increased human disturbance during summer. Since aquatic feeding areas occur in limited supply and serve an important physiological function, any impacts on feeding areas will affect the carrying capacity of the area for moose in summer.

Moose are intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Cottage and shoreline residential developments will lead to increase human activity in shoreline habitats and on adjacent water bodies. Increased human activity near an aquatic feeding area will likely reduce its use by moose. Development which affects the forest cover associated with the feeding site will also impact feeding site function. If human activity along the shoreline is visible from the shoreline aquatic feeding site, moose will be disturbed and may abandon the site.

Increased boat traffic associated with shoreline development will disturb moose and likely cause abandonment of the site. This impact extends to development on adjacent lands since increased boat traffic, no matter where it originates, will affect moose.

Dredging and dock construction may have significant impacts on the near shore aquatic plant community and hence on food supplies for moose. Additionally, docks are often sites of high human activity; busy docks that are visible to moose using aquatic feeding areas may play a role in abandonment of the site by moose. Docks not in use during spring and early summer will likely have benign effects. Dock construction on adjacent lands may present a threat to feeding area function depending on where anticipated boat traffic is likely to occur and whether moose can see activity on the dock from the feeding area.

Moose are known to avoid roads (AMEC Americas Limited 2005). Residential and cottage road networks may block moose from reaching aquatic feeding areas.

Changes in local water levels associated with the development could alter the volume and species composition of the aquatic plant community at the feeding site. These changes may affect the quality of the feeding site and, if impacts are severe, the area may be rendered useless as an aquatic feeding site.

Activities that may affect sediment and nutrient concentrations in aquatic or wetland habitat, such as site clearing and stormwater discharge, may alter aquatic plant communities. This can reduce the quality of moose-feeding habitat. Submergent aquatic vegetation is particularly susceptible to increases in nutrient concentrations and turbidity.

Timber clearing and building construction in conifer cover located near the area where aquatic plants are abundant will reduce the quality of the aquatic feeding site.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Aquatic feeding habitat for moose includes adjacent stands (120 m) of mixed or conifer forest, particularly those that provide thermal cover and/or travel corridors to other habitat features.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Cottage and waterfront residential development in aquatic feeding habitat for moose will destroy the ecological function of the habitat. Even a carefully designed development that avoids shoreline alteration (e.g., dredging and dock construction) and onshore conifer clearing will destroy an aquatic feeding habitat by introducing the element of human disturbance. If moose abandon a feeding area because there is human activity nearby, then the ecological function of that habitat has been destroyed. The best mitigation option is to avoid developing in the habitat.

For developments on lands adjacent to aquatic feeding habitat, it may be possible to mitigate some of the disturbance impacts associated with summertime human activity. Start by leaving a visual barrier between the development and the aquatic feeding habitat. Proponents should refer to the "Timber Management Guidelines for the Protection of Moose Aquatic Feeding Habitat" (OMNR 1988). The guidelines recommend a 120 m reserve of vegetation around aquatic feeding sites to provide security cover and undisturbed access to sites used by moose. Typically, these guidelines are applied to high and moderate aquatic use or potential use areas, as determined by a qualitative ranking procedure. The system of ranking is based on accessibility, size of the area, vegetation characteristics and evidence of use by moose.

Design road networks to allow moose unimpeded access to aquatic feeding areas.

Boating traffic from developments adjacent to aquatic feeding habitat should be managed and, where possible, directed away from the habitat. Even a moderate increase in boat activity can be expected to reduce the quality and ecological function of the feeding area. Boat access points should be located where they will not funnel boat traffic through or near aquatic feeding areas.

An effort should also be made to prevent pedestrian access to aquatic feeding areas. Trail systems associated with the development should be routed away from the shoreline where they pass aquatic feeding areas. Signage and a public education campaign may also help people understand the unique characteristics of the habitat, and the value of leaving it and the moose undisturbed.

In the end, the sensitivity of moose to human disturbance may make it impossible to successfully mitigate the negative impacts of cottage and waterfront residential development on lands adjacent to aquatic feeding habitat.

To mitigate impacts related to water level changes, and subsequent aquatic vegetation community changes, consider limiting the density of the development to control water-taking. This option may be particularly relevant where residential or cottage developments already exist, making it important to consider the cumulative impacts of consumptive water use. A water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the habitat. Lots should always be graded such that water is not directed toward the habitat.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Development has the greatest potential to disrupt the function of a site as an aquatic feeding area if it involves shoreline site alteration and increased human disturbance during summer. Aquatic feeding habitat for moose is most likely to be affected by marina and recreational beach developments. Because aquatic feeding habitat includes both the nearshore aquatic area and the adjacent lowland conifer forest cover, clearing of conifer for golf course development may also affect feeding habitat. Aquatic feeding areas occur in limited supply and serve an important physiological function, so any impacts on feeding areas will affect the carrying capacity of the area for moose in summer.

Moose are intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Increased human activity near an aquatic feeding area will reduce its use by moose. Development which affects the forest cover associated with the feeding site will also impact feeding site function. If human activity along the shoreline is visible from the shoreline aquatic feeding site, moose will be disturbed and may abandon the site.

Changes in local water levels associated with the development could alter the volume and species composition of the aquatic plant community at the feeding site. These changes may affect the quality of the feeding site and, if impacts are severe, the area may be rendered useless as an aquatic feeding site.

Increased boat traffic associated with marina development will disturb moose and likely cause abandonment of the site. This impact extends to development on adjacent lands since increased boat traffic, no matter where it originates, will affect moose.

Dredging and dock construction may have significant impacts on the near shore aquatic plant community and hence on food supplies for moose. Additionally, marina docks are sites of high human activity; busy docks that are visible to moose using aquatic feeding areas may play a role in abandonment of the site by moose. Dock construction on adjacent lands may present a threat to feeding area function depending on where anticipated boat traffic is likely to occur and whether moose can see activity on the dock from the feeding area.

Moose are known to avoid roads (AMEC Americas Limited 2005). Roads associated with the recreational development may block moose from reaching aquatic feeding areas.

Activities that may affect sediment and nutrient concentrations in aquatic or wetland habitat, such as site clearing and stormwater discharge, may alter aquatic plant communities. This can reduce the quality of moose-feeding habitat. Submergent aquatic vegetation is particularly susceptible to increases in nutrient concentrations and turbidity.

Timber clearing and building construction in conifer cover located near the area where aquatic plants are abundant will reduce the quality of the aquatic feeding site.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Aquatic feeding habitat for moose includes adjacent stands (120 m) of mixed or conifer forest, particularly those that provide thermal cover and/or travel corridors to other habitat features.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Recreational development in aquatic feeding habitat for moose will destroy the ecological function of the habitat. Even a carefully designed development that avoids shoreline alteration (e.g., dredging and dock construction) and onshore conifer clearing will destroy an aquatic feeding habitat by introducing the element of human disturbance. If moose abandon a feeding area because there is human activity nearby, then the ecological function of that habitat has been destroyed. The best mitigation option is to avoid developing in the habitat.

For developments on lands adjacent to aquatic feeding habitat, it may be possible to mitigate some of the disturbance impacts associated with summertime human activity. Start by leaving a visual barrier between the development and the aquatic feeding habitat. Proponents should refer to the "Timber Management Guidelines for the Protection of Moose Aquatic Feeding Habitat" (OMNR 1988). The guidelines recommend a 120 m reserve of vegetation around aquatic feeding sites to provide security cover and undisturbed access to sites used by moose. Typically, these guidelines are applied to high and moderate aquatic use or potential use areas, as determined by a qualitative ranking procedure. The system of ranking is based on accessibility, size of the area, vegetation characteristics and evidence of use by moose.

A water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the habitat.

Design road networks to allow moose unimpeded access to aquatic feeding areas.

Boating traffic from developments adjacent to aquatic feeding habitat should be managed and, where possible, directed away from the habitat. Even a moderate increase in boat activity can be expected to reduce the quality and ecological function of the feeding area.

An effort should also be made to prevent pedestrian access to aquatic feeding areas. Signage and a public education campaign may help people understand the unique characteristics of the habitat, and the value of leaving it and the moose undisturbed.

Golf courses should always be developed so that fairways and associated playing areas avoid shorelines that support aquatic feeding habitat for moose. Additionally, design fairways, greens and tees around any existing lowland coniferous forest cover to avoid diminishing the quality of the feeding area and the local carrying capacity for moose.

In the end, the sensitivity of moose to human disturbance may make it impossible to successfully mitigate the negative impacts of recreational development on lands adjacent to aquatic feeding habitat.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Moose aquatic feeding areas have the potential to be affected by mine development.

Human activity at the mine site during construction and operation may disturb moose. Moose are intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Increased human activity near an aquatic feeding area will likely reduce its use by moose.

Moose are also known to respond to noise in the environment, e.g., noise pollution and disturbance are listed as threats in Nova Scotia's recovery plan for mainland moose (NSDNR 2007). Whether moose will respond to operational noise at a mine site is unknown. In a study of behavioural and physiological responses by moose to noise disturbance at a military site in Norway, Anderson et al. (1996) concluded that sources of disturbance identifiable by moose as human elicited flight responses at greater distances and elevated heart rates for longer periods than disturbances that were recognized as mechanical. This study was conducted in the fall; the authors caution that the same level of disturbance in the winter or during calving could have more detrimental effects. The same could also be true of the aquatic feeding period.

Removal of lowland conifer vegetation near aquatic feeding areas may result in the area being deserted by moose due to loss of adjacent cover.

Sediments and contaminants from tailings have the potential to destroy feeding areas. This may occur if submergent plant species are directly affected by tailings, if sediments alter water transparency, or if the pH of the water changes. The loss of submergent vegetation will result in the habitat's loss of ecological function as a moose feeding site.

Moose are known to avoid roads (AMEC Americas Limited 2005). Access roads for the mine may block moose from reaching aquatic feeding areas.

Changes in local water levels associated with the development could alter the volume and species composition of the aquatic plant community at the feeding site. These changes may affect the quality of the feeding site and, if impacts are severe, the area may be rendered useless as an aquatic feeding site.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Aquatic feeding habitat for moose includes adjacent stands (120 m) of mixed or conifer forest, particularly those that provide thermal cover and/or travel corridors to other habitat features.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Because aquatic feeding habitat includes both the nearshore aquatic area and the adjacent lowland conifer forest cover, clearing of the conifer for development purposes will destroy the ecological function of the feeding habitat. Additionally, the construction and operation of a mine would introduce the element of human disturbance and noise. If moose abandon a feeding area because there is human activity nearby, then the ecological function of that habitat has been destroyed. The best mitigation option is to avoid developing in the habitat.

For developments on lands adjacent to aquatic feeding habitat, it may be possible to mitigate some of the disturbance impacts associated with summertime human activity. Start by leaving a visual barrier between the development and the aquatic feeding habitat. Proponents should refer to the "Timber Management Guidelines for the Protection of Moose Aquatic Feeding Habitat" (OMNR 1988). The guidelines recommend a 120 m reserve of vegetation around aquatic feeding sites to provide security cover and undisturbed access to sites used by moose. Typically, these guidelines are applied to high and moderate aquatic use or potential use areas, as determined by a qualitative ranking procedure. The system of ranking is based on accessibility, size of the area, vegetation characteristics and evidence of use by moose.

Another option for mitigating the impacts of disturbance and operational noise on moose use of aquatic feeding areas is to suspend mine operations during the time when moose are expected to use the habitat (i.e., typically June and July).

To mitigate impacts from contamination by mine tailings, contain tailings in an area that is well removed from the habitat. Effluent from mine tailings needs to be treated prior to discharge to a watercourse or water body that supports a moose feeding area. Discharged water should be of high enough quality that it has no negative effects on downstream submergent aquatic vegetation.

Design road networks to allow moose unimpeded access to aquatic feeding areas.

A water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the habitat.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Shoreline areas are attractive locations for wind power facilities due to the frequency and velocity of winds. Aquatic feeding areas for moose occur in limited supply and serve an important physiological function; any impacts on feeding areas will affect the carrying capacity of the area for moose in summer.

Development in aquatic feeding habitat, either nearshore and onshore, will lead to loss of the habitat's ecological function. Onshore placement of turbines in aquatic feeding habitat will require forest clearing, which removes critical cover elements of the habitat. Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Nearshore placement of turbines will require alteration of the shoreline (e.g., drilling to sink supports, dredging, filling) that will destroy the aquatic portion of the habitat.

The ecological function of aquatic feeding areas may also be affected by wind power development on adjacent lands. Construction and operational noise may disturb moose using the feeding area, access roads may block moose from reaching the shore, and sedimentation from the construction site may lead to changes in aquatic vegetation communities in the feeding area.

Moose are intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Human activities associated with construction and turbine maintenance will likely disturb moose using the feeding habitat if they are within visual range. Moose are also known to respond to noise in the environment, e.g., noise pollution and disturbance are listed as threats in Nova Scotia's recovery plan for mainland moose (NSDNR 2007). However, little seems to be known about moose responses to turbine noise in particular, or to the physical movement of turbines during operation. In a study of behavioural and physiological responses by moose to noise disturbance at a military site in Norway, Anderson et al. (1996) concluded that sources of disturbance identifiable by moose as human elicited flight responses at greater distances and elevated heart rates for longer periods than disturbances that were recognized as mechanical. This study was conducted in the fall; the authors caution that the same level of disturbance in the winter or during calving could have more detrimental effects. The same could also be true of the aquatic feeding period.

Moose are known to avoid roads (AMEC Americas Limited 2005). Access roads may block moose from reaching aquatic feeding areas.

Construction may lead to the introduction of sediment to the wetland component of the aquatic feeding area. Sedimentation has the potential to change the composition of nearshore aquatic substrates, which could affect water levels and change the species composition of aquatic food plants.

Mitigation Options: Wind Power Facilities

No renewable energy project may be developed within or expanded into aquatic feeding habitat in a provincially significant southern or coastal wetland (Ontario Regulation 359/09:37.1 and 37.2). The siting of wind turbines within 120 m of the outer edge of an aquatic feeding habitat (which includes 120 m of adjacent forest) located in a provincially significant northern wetland or elsewhere should be avoided. This distance is measured from the edge of the habitat to the tip of the turbine blade when it is rotated toward the habitat (as opposed to from the base of the turbine). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Eckhart Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development that involves shoreline alteration or clearance of conifer cover in aquatic feeding areas will result in loss of the habitat. The best mitigation is to avoid developing in the habitat.

For development on lands adjacent to aquatic feeding habitats, a visual barrier needs to be maintained between the development and the aquatic feeding habitat. Proponents should refer to the "Timber Management Guidelines for the Protection of Moose Aquatic Feeding Habitat" (OMNR 1988). The guidelines recommend a 120-metre reserve of vegetation around aquatic feeding sites to provide security cover and undisturbed access to sites used by moose. Typically, these guidelines are applied to high and moderate aquatic use or potential use areas, as determined by a qualitative ranking procedure. The system of ranking is based on accessibility, size of the area, vegetation characteristics and evidence of use by moose.

Impacts related to human disturbance can also be mitigated by scheduling all construction and maintenance to occur when moose are not using the habitat. If post-construction monitoring suggests that turbine noise and movement are discouraging moose from using the habitat, consideration should be given to shutting turbines down during the time when moose are expected to use the habitat (i.e., typically June and July).

Design road networks to allow moose unimpeded access to aquatic feeding areas. Ensure that surface water drainage from roads does introduce sediment into the wetland that supports the aquatic feeding habitat.

During the construction phase of the project, appropriate sediment control measures should be used to prevent sedimentation in nearby wetlands.

Potential Development Effects: Solar Power Facilities

Development in aquatic feeding habitat, either nearshore and onshore, will lead to loss of the habitat's ecological function. Onshore placement of solar panels in aquatic feeding habitat will require forest clearing, which removes critical cover elements of the habitat. Loss of cover components in the habitat will reduce its quality and ecological function.

The ecological function of aquatic feeding areas may also be affected by solar power development on adjacent lands. Construction and maintenance activities may disturb moose using the feeding area, access roads may block moose from reaching the shore, and sedimentation from the construction site may lead to changes in aquatic vegetation communities in the feeding area.

Moose are intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Human activities associated with construction and maintenance will likely disturb moose using the feeding habitat if they are within visual range. Moose are also known to respond to noise in the environment, e.g., noise pollution and disturbance are listed as threats in Nova Scotia's recovery plan for mainland moose (NSDNR 2007). In a study of behavioural and physiological responses by moose to noise disturbance at a military site in Norway, Anderson et al. (1996) concluded that sources of disturbance identifiable by moose as human elicited flight responses at greater distances and elevated heart rates for longer periods than disturbances that were recognized as mechanical. This study was conducted in the fall; the authors caution that the same level of disturbance in the winter or during calving could have more detrimental effects. The same could also be true of the aquatic feeding period.

Moose are known to avoid roads (AMEC Americas Limited 2005). Access roads may block moose from reaching aquatic feeding areas.

Construction may lead to the introduction of sediment to the wetland component of the aquatic feeding area. Sedimentation has the potential to change the composition of nearshore aquatic substrates, which could affect water levels and change the species composition of aquatic food plants.

Changes in local water levels associated with the development could alter the volume and species composition of the aquatic plant community at the feeding site. These changes may affect the quality of the feeding site and, if impacts are severe, the area may be rendered useless as an aquatic feeding site.

Activities that may affect sediment and nutrient concentrations in aquatic or wetland habitat, such as site clearing and stormwater discharge, may alter aquatic plant communities. This can reduce the quality of moose-feeding habitat. Submergent aquatic vegetation is particularly susceptible to increases in nutrient concentrations and turbidity.

Mitigation Options: Solar Power Facilities

No renewable energy project may be developed within or expanded into aquatic feeding habitat in a provincially significant southern or coastal wetland (Ontario Regulation 359/09:37.1 and 37.2). The siting of solar panel arrays within 120 m of the outer edge of an aquatic feeding habitat (which includes 120 m of adjacent forest) located in a provincially significant northern wetland or elsewhere should be avoided. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing for the installation of solar panels in aquatic feeding habitat for moose will destroy the ecological function of the habitat by removing critical cover components. Human disturbance associated with the development, e.g., regular maintenance activity, has the potential to adversely affect moose use of the habitat. If moose abandon a feeding area because there is human activity nearby, then the ecological function of that habitat has been destroyed. The best mitigation option is to avoid developing in the habitat.

For developments on lands adjacent to aquatic feeding habitat, it may be possible to mitigate some of the disturbance impacts associated with summertime human activity. Start by leaving a visual barrier of natural vegetation between the development and the aquatic feeding habitat. Proponents should refer to the "Timber Management Guidelines for the Protection of Moose Aquatic Feeding Habitat" (OMNR 1988). The guidelines recommend a 120 m reserve of vegetation around aquatic feeding sites to provide security cover and undisturbed access to sites used by moose. Typically, these guidelines are applied to high and moderate aquatic use or potential use areas, as determined by a qualitative ranking procedure. The system of ranking is based on accessibility, size of the area, vegetation characteristics and evidence of use by moose.

Schedule construction and regular maintenance activities to occur when moose are not using the habitat. Keep people and machinery out of the habitat at all times.

Design road networks to allow moose unimpeded access to aquatic feeding areas. Ensure that surface water drainage from roads does introduce sediment into the wetland that supports the aquatic feeding habitat. During the construction phase of the project, appropriate sediment control measures should be used to prevent sedimentation in nearby wetlands.

A water balance study should be completed to demonstrate that there will be no discernable change in the quantity or quality of water that is directed to the habitat.

ROAD DEVELOPMENT

Potential Development Effects

Road construction and related activities designed to manage hydrology and surface water flow may affect the ecological function of aquatic feeding habitat through: 1) direct habitat loss due to the road/highway right-of-way footprint; 2) changes to water levels of nearby wetland and shallow water areas (e.g., beaver ponds), which consequently alter the quantity and species composition of aquatic vegetation; 3) roads as behavioural "barriers" for moose; and 4) human disturbance (e.g., noise, movement).

Because aquatic feeding habitat includes both the nearshore aquatic area and the adjacent lowland conifer forest cover, clearing of the conifer for road development will physically destroy the portion of the habitat that is removed and compromise the ecological function of the remaining habitat.

Changes in local water levels associated with the development could alter the volume and species composition of the aquatic plant community at the feeding site. These changes may affect the quality of the feeding site and, if impacts are severe, the area may be rendered useless as an aquatic feeding site. Road construction may also lead to the introduction of sediment to the wetland component of the aquatic feeding area. Sedimentation has the potential to change the composition of nearshore aquatic substrates, which could affect water levels and change the species composition of aquatic food plants.

Compounds containing salt are typically used to de-ice roads in winter, and have the potential to contaminate the habitat.

Moose are known to avoid roads (AMEC Americas Limited 2005). Forman and Deblinger (2009) reported that the "road-effect zone" for moose extends over 1 km outward from the road itself. Roads may block moose from reaching aquatic feeding areas.

Moose are also intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Human activities associated with road construction and use will likely disturb moose using the feeding habitat if they are within visual range. Moose are also known to respond to noise in the environment, e.g., noise pollution and disturbance are listed as threats in Nova Scotia's recovery plan for mainland moose (NSDNR 2007). In their study of a Massachusetts suburban road, Formand and Deblinger (2009) reported that traffic noise exerted effects on moose (and other wildlife) along most of the road length.

Additionally, ecological function may be impaired if moose using the habitat suffer high rates of mortality due to the development. If there is active aquatic feeding habitat near the road/highway, there may be moose mortality due to vehicular collisions, particularly if road shoulders and rights-of-way are attractive because of the residual presence of road salt from winter application. A report from Maine (Maine Interagency Work Group on Wildlife/Motor Vehicle Collisions 2001) found that most moose collision sites had wetland habitat at or near (i.e., within 50 m of) the crash site.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Aquatic feeding habitat for moose includes adjacent stands (120 m) of mixed or conifer forest, particularly those that provide thermal cover and/or travel corridors to other habitat features.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for road construction in aquatic feeding habitat will destroy the affected habitat, e.g., clearing lowland conifer cover, and reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

For development on lands adjacent to aquatic feeding habitats, a visual barrier needs to be maintained between the development and the aquatic feeding habitat. Proponents should refer to the "Timber Management Guidelines for the Protection of Moose Aquatic Feeding Habitat" (OMNR 1988). The guidelines recommend a 120-metre reserve of vegetation around aquatic feeding sites to provide security cover and undisturbed access to sites used by moose. Typically, these guidelines are applied to high and moderate aquatic use or potential use areas, as determined by a qualitative ranking procedure. The system of ranking is based on accessibility, size of the area, vegetation characteristics and evidence of use by moose.

Minimize the amount of affected habitat by making the road footprint where it affects the habitat as small as possible. Allow the road to follow the natural contours of the route to minimize the need for fill, and route the road as close to the edge of the habitat as possible to minimize the amount of forest cover that will need to be cleared.

Hydro-geological studies should be undertaken to determine if the roadbed or ditches will intercept groundwater flow to the wetland. If this is likely to occur, no roadside ditches should be constructed. A hydro-geologist should determine the best means of ensuring that groundwater flow continues through the base of the road. This may require using a permeable base, such as coarse rocks or gravel, that will not inhibit groundwater flow. Sufficient culverts should be installed under the road to ensure free movement of surface water and shallow groundwater.

During the construction phase of the project, appropriate sediment control measures should be used to prevent sedimentation in nearby wetlands. After completion, ensure that surface water drainage from roads does not introduce sediment into the aquatic feeding habitat. If surface runoff and potential introduction of contaminants into the habitat are a concern, appropriate stormwater management facilities should be built and maintained. Consideration should be given to using de-icing compounds other than salt in the vicinity of habitat.

Roads should be laid out where they will not fragment habitat and interfere with moose travelling to and from different areas of the aquatic feeding habitat. Limiting vehicle speed on roads developed adjacent to aquatic feeding habitat may help control traffic noise and mitigate, at least to some extent, road-related disturbance effects on moose.

Schedule construction and maintenance of roads during fall or winter, when moose are not using aquatic feeding habitats. Avoid using herbicides or pesticides to control roadside vegetation where the road runs near the habitat.

If moose-vehicle collisions are likely, a wide variety of both vehicle-centred and moose-centred mitigations are available. These include: signs, speed limit reductions, right-of-way brush and vegetation cutting, reflectors, noise emitters, fencing, and overpasses. In a study of highway crossing by moose in Quebec, Dussault et al. (2007) found that moose tended to cross road segments characterized by a high proportion of browse stands, coniferous forest cover, and valley topography with brackish pools. The authors recommended focusing mitigation measures on this type of road segment, and using empirical data about the locations of vehicle-wildlife collisions to plan mitigation measures at a fine scale.

INDEX #25: WATERFOWL NESTING AREA

Ecoregions:	All of Ontario
Species Group:	Waterfowl: Trumpeter Swan, Canada Goose, American Green-winged Teal, American Black Duck, Mallard, Northern Pintail, Blue-winged Teal, Northern Shoveler, Gadwall, American Wigeon, Wood Duck, Hooded Merganser, Common Merganser, Red-breasted Merganser, Bufflehead, Common Goldeneye
Significant Wildlife Habitat Category:	Rare or Specialized Habitat
Functional Habitat:	Waterfowl Nesting Area
Habitat Features:	Upland habitats (< 120 m wide) adjacent to wetlands Note: Includes adjacency to Provincially Significant Wetlands

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Waterfowl in the guild covered by this index commonly nest in upland habitat, usually grasslands, located near marshes and other wetlands, ponds, and lakes. Most nests are located within 100 m of water but it is not unusual to find nests 500 m or more from the water's edge. Once the eggs hatch, hens lead their broods overland to the water.

The wetland itself is used heavily by these birds throughout the year, but for successful reproduction, marshes must have an adequate supply of adjacent upland area offering habitat suitable for nesting. Without an adequate supply of nesting habitat surrounding wetlands, ducks and geese will be forced to nest in poor quality sites. This results in low reproductive success and ultimately a decline in numbers.

Most waterfowl in this group select upland areas composed of grasses, sedges, rushes, and low shrubs. Some species will use adjacent hay fields as nesting sites. The American Black Duck is known to nest in upland forest habitat, but often in or near beaver ponds in these upland areas. The exact species composition of the plant community seems to be a secondary consideration to the structure provided. Upland habitat adjacent to a wetland should be wide enough so that predators like Raccoons, Red Foxes, Coyotes, and Striped Skunks have difficulty locating nests. These bands of cover around a wetland generally experience very high rates of nest predation.

For most species, except the pintail, presence of residual vegetation from previous years is important.

See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

In the context of waterfowl nesting habitat, most development effects can be considered as those affecting the land adjacent to wetlands (i.e., impacts within 120 m of wetlands). For most waterfowl species, over 90% of nests are likely to occur within 120 m of water.

Development on grasslands adjacent to wetland habitat can significantly reduce the function of upland habitat as waterfowl nesting areas. The loss of extensive areas of grassland habitat represents the greatest effect. As the supply of nesting habitat surrounding wetlands is reduced, so too is the productive capability of the wetland for waterfowl (i.e., fewer areas to nest and reduced nesting success). The loss of forested habitat near wetlands may destroy habitat for tree-nesting species.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Building and lot-clearing activities which result in a simplified structural complexity of grassland habitat (i.e., mowing, lawn planting, etc) will reduce or destroy the ecological function of nesting habitat. Clearing of forested area may also result in loss of nesting habitat for tree-nesting species.

Site alterations which isolate nesting habitat from wetlands pose a hazard to ducklings. Once eggs have hatched, the hen leads the ducklings to the marsh. If they have to walk through open areas, the brood is exposed to mortality from avian and other predators.

The water body or marsh adjacent to upland nesting habitat is typically important foraging habitat for both adults and broods. Therefore it is important that no major alterations are made to this habitat. Potential indirect impacts on the water body or marsh are changes in water quality due to increased inputs of sediments, nutrients or contaminants (e.g., road salt), or changes in water levels due to increased runoff and/or decreased groundwater inputs. Changes in water levels or nutrient regimes will alter the pattern of vegetation distribution within wetlands and possibly species composition. This in turn can affect the ability of the site to attract nesting waterfowl.

Residential developments in or adjacent to waterfowl nesting habitat will likely increase human activity and the number of pets in that nesting habitat. People from developments on or near shorelines tend to use those shorelines for walking and swimming. Disturbance effects and predation by cats and dogs will lead to reduced waterfowl reproductive success. If disturbance is frequent, nesting may be prevented entirely and affected pairs may abandon the habitat. Predators such as raccoons, gulls, and skunks appear to be attracted to areas of human activity. These predators can kill nesting ducks and destroy eggs. If the upland nesting habitat is reduced to a thin band, virtually all production may be lost to predators.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Waterfowl nesting SWH extends 120 m from a wetland (> 0.5 ha), or from a wetland (> 0.5 ha) and any small wetlands (< 0.5 ha) within 120 m, or a cluster of 3 or more small wetlands (< 0.5 ha) within 120 m of eachother, where waterfowl nesting is known to occur.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Site clearing and construction in waterfowl nesting habitat will destroy the affected habitat, and lead to increased human and predator activity. Additionally, development within waterfowl nesting habitat has the potential to form a barrier between the upland and wetland components of the habitat, blocking access to the wetland by newly hatched broods. Habitat loss and increased exposure to disturbance and predation will likely result in reduced reproductive success, and possible abandonment of the habitat, which in turn will reduce the ecological function of the retained habitat. The best mitigation option is to avoid developing in these habitats.

When complete avoidance of the habitat is not possible, and the SWH is very large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; 2) placing it at an edge; and 3) placing it where nest density is lowest. Edge placement will maximize the amount of undisturbed habitat and minimize the barrier effect. Schedule construction to occur in the fall or winter, when waterfowl are not nesting in the habitat. Consider installing fencing around the development to keep people and pets off the habitat; if fencing is used, it is very important to ensure that it does not block access to the wetland by broods from the edges of the habitat. Signage and a public education campaign may help people understand the unique characteristics of waterfowl nesting habitat, and the value of leaving it undisturbed. Even with these mitigation measures in place, developing within waterfowl nesting habitat (even when it is very large) will damage the feature and reduce its ecological function. It may be possible to at least partly compensate for these losses by enhancing the quality of the retained upland habitat (e.g., seeding to create areas of dense cover, adding nest boxes for cavity-nesting species, etc.), with a view to attracting more nesting pairs to the undisturbed portions of the habitat. For guidance on how to enhance upland waterfowl nesting habitat, consult with the Ontario Ministry of Natural Resources and/or Ducks Unlimited Canada.

Grasslands in nesting habitat should never be mowed during the nesting season.

A water balance study should be conducted for any development proposed within or adjacent to waterfowl nesting habitat to ensure no negative effects to the associated wetland. Manage stormwater from the development to ensure that there are no changes to the quality or quantity of water in the water body or wetland associated with the nesting habitat.

Development on lands adjacent to waterfowl nesting habitat requires careful site planning. Ideally, buffers of 250 m should be maintained between the development and the edge of the waterfowl nesting habitat; buffers narrower than this can act as ecological traps for nesting waterfowl (and other wildlife species). Narrower buffers may succeed in attracting waterfowl to the area, but provide insufficient protection from predators originating from the development (e.g., cats, raccoons). Where possible, buffers of natural upland habitat even larger than 250 m should be established. If these areas must be developed, there may be opportunity to reconstruct (or establish) nesting habitat in other areas away from development. Reconstruction would involve establishing large areas (i.e., 4 to 10 ha) of upland grassland habitat that is connected to the wetland. The growth of native wet meadow (sedges, rushes, etc.) and grassland plants should be encouraged. Steps should be taken to prevent the invasion of nesting habitat by trees. Tallgrass prairie species such as Big Bluestem, Indian Grass, and Switchgrass provide excellent nesting habitat. The species information in the Appendix, along with the associated references, may be used to create nesting habitat for target waterfowl species.

For developments adjacent to waterfowl nesting habitat, human disturbance effects can be minimized by ensuring that roads and paths are routed away from nesting habitat. People should be encouraged to keep all pets, including cats, on leashes when they are outside. Consider installing fencing around the development to prevent people and pets from accessing the habitat. If fencing is used, it is very important to ensure that it does not block access to the wetland by broods from the edges of the habitat. Signage and a public education campaign may help people understand the unique characteristics of waterfowl nesting habitat, and the value of leaving it undisturbed.

Grasslands in nesting habitat should never be mowed during the nesting season.

The density of cavity-nesting birds can often be increased through provision of nest boxes. This should only be done if a commitment to maintaining the boxes can be made.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Waterfowl nesting habitat is most likely to be affected by golf courses.

Conversion of grassland habitat to closely mowed fairways, green, and tees will disrupt or eliminate the function of nesting habitat.

The adjacent water body or marsh is typically important for foraging for adults and may also be brood habitat. Potential indirect impacts on the water body or marsh are changes in water quality due to increased inputs of fertilizers and pesticides, or changes in water levels due to irrigation activities. Changes in water levels or nutrient regimes will alter the pattern of vegetation distribution within wetlands and possibly species composition. This in turn can affect the ability of the site to attract and support nesting waterfowl.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Waterfowl nesting SWH extends 120 m from a wetland (> 0.5 ha), or from a wetland (> 0.5 ha) and any small wetlands (< 0.5 ha) within 120 m, or a cluster of 3 or more small wetlands (< 0.5 ha) within 120 m of eachother, where waterfowl nesting is known to occur.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development of golf course fairways, tees and greens in waterfowl nesting habitat will destroy the affected habitat. Additionally, any development within waterfowl nesting habitat is likely to form a barrier between the upland and wetland components of the habitat, blocking access to the wetland by newly hatched broods. Habitat loss and increased disturbance will likely result in reduced reproductive success, which in turn will reduce the ecological function of the retained habitat. The best mitigation option is to avoid developing in these habitats.

When complete avoidance of the habitat is not possible, and the SWH is very large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; 2) placing it at an edge; and 3) placing it where nest density is lowest. Edge placement will maximize the amount of undisturbed habitat and minimize the barrier effect. Schedule construction to occur in the fall or winter, when waterfowl are not nesting in the habitat. Consider installing fencing around the development to keep people and machinery off the habitat. If fencing is used, it is very important to ensure that it does not block access to the wetland by broods from the edges of the habitat. Signage and a public education campaign may help people understand the unique characteristics of waterfowl nesting habitat, and the value of leaving it undisturbed. Even with these mitigation measures in place, developing within waterfowl nesting habitat (even when it is very large) will damage the feature and reduce its ecological function. It may be possible to at least partly compensate for these losses by enhancing the quality of the retained upland habitat (e.g., seeding to create areas of dense cover, adding nest boxes for cavity-nesting species, etc.), with a view to attracting more nesting pairs to the undisturbed portions of the habitat. For guidance on how to enhance upland waterfowl nesting habitat, consult with the Ontario Ministry of Natural Resources and/or Ducks Unlimited Canada.

Grasslands in nesting habitat should never be mowed during the nesting season.

A water balance study should be conducted for any development proposed within or adjacent to waterfowl nesting habitat to ensure no negative effects to the associated wetland. Manage stormwater from the development to ensure that there are no changes to the quality or quantity of water in the water body or wetland associated with the nesting habitat.

Development on lands adjacent to waterfowl nesting habitat requires careful site planning. Ideally, buffers of 250 m should be maintained between the development and the edge of the waterfowl nesting habitat; buffers narrower than this can act as ecological traps for nesting waterfowl (and other wildlife species). Narrower buffers may succeed in attracting waterfowl to the area, but provide insufficient protection from predators. Where possible, buffers of natural upland habitat even larger than 250 m should be established. If these areas must be developed, there may be opportunity to reconstruct (or establish) nesting habitat in other areas away from development. Reconstruction would involve establishing large areas (i.e., 4 to 10 ha) of upland grassland habitat that is connected to the wetland. The growth of native wet meadow (sedges, rushes, etc.) and grassland plants should be encouraged. Steps should be taken to prevent the invasion of nesting habitat by trees. Tallgrass prairie species such as Big Bluestem, Indian Grass, and Switchgrass provide excellent nesting habitat. The species information in the Appendix, along with the associated references, may be used to create nesting habitat for target waterfowl species.

Human disturbance effects on nesting habitat can be minimized by leaving a visual barrier of vegetation between active playing areas (including cart pathways) and nesting habitat. Avoid using these buffer strips as rough. Rough areas experience high levels of human activity, which may decrease nesting success.

Grading for the golf course should not significantly alter the drainage patterns and size of the watershed for the water body or marsh associated with the waterfowl nesting habitat. Runoff from greens, tees, and fairways should not flow directly to these water bodies. Retained buffer strips need to be wide enough to prevent fertilizers and pesticides from reaching the wetland.

Grasslands should not be mowed until after the nesting season. At golf courses, there may be opportunities to create additional grasslands that will augment existing waterfowl nesting habitat.

Density of cavity-nesting birds can often be increased through provision of nest boxes. This should only be done if a commitment to maintaining the boxes can be made.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Sand and gravel pits and stone quarries might be developed in grassland habitat that is significant waterfowl nesting habitat. Removal of grassland overburden for extraction of aggregates results in loss of the habitat.

Indirect effects of aggregate developments on waterfowl nesting habitat include impacts on the water body or wetland that is associated with the nesting habitat. Water levels could be affected by dewatering activities, lowering of the water table, or removal of some of the surface water drainage area of the water body.

Mines also have the potential to affect waterfowl nesting habitat. Removal of grassland for the mine and related structures represents physical destruction of the habitat. Mine tailings can cover habitat and contaminate associated wetlands.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Waterfowl nesting SWH extends 120 m from a wetland (> 0.5 ha), or from a wetland (> 0.5 ha) and any small wetlands (< 0.5 ha) within 120 m, or a cluster of 3 or more small wetlands (< 0.5 ha) within 120 m of eachother, where waterfowl nesting is known to occur.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Aggregate development in waterfowl nesting habitat will destroy the affected habitat. Additionally, any development within waterfowl nesting habitat is likely to form a barrier between the upland and wetland components of the habitat, blocking access to the wetland by newly hatched broods. Habitat loss and increased disturbance will likely result in reduced reproductive success, which in turn will reduce the ecological function of the retained habitat. The best mitigation option is to avoid developing in these habitats.

When complete avoidance of the habitat is not possible, and the SWH is very large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; 2) placing it at an edge; and 3) placing it where nest density is lowest. Edge placement will maximize the amount of undisturbed habitat and minimize the barrier effect. Schedule construction to occur in the fall or winter, when waterfowl are not nesting in the habitat. Consider installing fencing around the development to keep people and machinery off the habitat. If fencing is used, it is very important to ensure that it does not block access to the wetland by broods from the edges of the habitat. Signage and a public education campaign may help people understand the unique characteristics of waterfowl nesting habitat, and the value of leaving it undisturbed.

Even with these mitigation measures in place, developing within waterfowl nesting habitat (even when it is very large) will damage the feature and reduce its ecological function. It may be possible to at least partly compensate for these losses by enhancing the quality of the retained upland habitat (e.g., seeding to create areas of dense cover, adding nest boxes for cavity-nesting species, etc.), with a view to attracting more nesting pairs to the undisturbed portions of the habitat. For guidance on how to enhance upland waterfowl nesting habitat, consult with the Ontario Ministry of Natural Resources and/or Ducks Unlimited Canada. It may also be possible, over time, to rehabilitate exhausted pits and quarries to habitat suitable for waterfowl nesting. Adjacent retained habitat will provide an appropriate seed source. Where extraction has occurred below the water table, rehabilitation may include creation of wetland for brood rearing. There are numerous examples in Ontario of native ecosystems in abandoned pit and quarry sites, including dry and wet meadow, marsh, fen, shrub swamp, and tallgrass prairie habitat (Browning and Tan 2002).

Grasslands in nesting habitat should never be mowed during the nesting season.

A water balance study should be conducted for any development proposed within or adjacent to waterfowl nesting habitat to ensure no negative effects to the associated wetland. Manage stormwater from the development to ensure that there are no changes to the quality or quantity of water in the water body or wetland associated with the nesting habitat.

Development on lands adjacent to waterfowl nesting habitat requires careful site planning. Ideally, buffers of 250 m should be maintained between the development and the edge of the waterfowl nesting habitat; buffers narrower than this can act as ecological traps for nesting waterfowl (and other wildlife species). Narrower buffers may succeed in attracting waterfowl to the area, but provide insufficient protection from predators. Where possible, buffers of natural upland habitat even larger than 250 m should be established. If these areas must be developed, there may be opportunity to reconstruct (or establish) nesting habitat in other areas away from development. Reconstruction would involve establishing large areas (i.e., 4 to 10 ha) of upland grassland habitat that is connected to the wetland. The growth of native wet meadow (sedges, rushes, etc.) and grassland plants should be encouraged. Steps should be taken to prevent the invasion of nesting habitat by trees. Tallgrass prairie species such as Big Bluestem, Indian Grass, and Switchgrass provide excellent nesting habitat. The species information in the Appendix, along with the associated references, may be used to create nesting habitat for target waterfowl species.

It is important during the planning stages to determine if a pit or quarry will have adverse impacts on water levels in the water body or wetland that is attracting nesting waterfowl. If dewatering activities have the potential to lower water levels, it may be possible to mitigate this by installing an impermeable barrier around the pit or quarry, or by pumping clean water to the wetland. Water levels could also be lowered if the pit or quarry removes some of the wetland's surface drainage area, and the effects of this could potentially be mitigated by pumping water. Alternatively, it is possible that water levels in the water body or wetland could be increased by dewatering outflow. If this outcome is likely, water should be directed elsewhere so that there is no change in the habitat's water levels.

Any water directed to the water body or wetland from pits and quarries should first flow into a settling pond to remove any sediments and excess nutrients. Mine tailings and tailings runoff should be directed away from waterfowl nesting habitat.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Wind energy projects have the potential to adversely affect birds through direct fatalities, disturbance, and habitat loss (Kingsley and Whittam 2005; Environment Canada 2007a). With a few important exceptions (e.g., raptors in California), avian fatalities at wind power facilities tend to be low relative to other anthropogenic mortality factors (Kingsley and Whittam 2005). Collisions occur mainly at sites where there are unusual concentrations of birds (e.g., migration corridors) and wind turbines, or where the behaviour of birds puts them at risk (e.g., aerial courtship displaying) (Arcus Renewable Energy Consulting Ltd. 2007). Limited data suggest that waterfowl are not overly susceptible to being struck by turbines, and that they do not avoid wind power facilities for nesting (James 2008).

Greater adverse effects from wind power facility development result from habitat loss and disturbance (Kingsley and Whittam 2005).

Construction of pads for turbines and permanent access roads in waterfowl nesting habitat represents a direct loss of habitat. Human activities associated with construction and regular maintenance of turbines and associated infrastructure may disturb nesting and brood rearing birds, leading to reduced reproductive success.

Roads built between the marsh and nesting habitat present difficulties for broods moving to wetlands. Hens may try to direct their broods around barriers like roads and buildings etc. This leaves ducklings exposed to predators for longer periods of time, reducing their chances of survival.

Mitigation Options: Wind Power Facilities

Waterfowl nesting SWH extends 120 m from a wetland (> 0.5 ha), or from a wetland (> 0.5 ha) and any small wetlands (< 0.5 ha) within 120 m, or a cluster of 3 or more small wetlands (< 0.5 ha) within 120 m of eachother, where waterfowl nesting is known to occur.

No renewable energy project may be developed within or expanded into waterfowl nesting habitat located in a provincially significant southern or coastal wetland (Ontario Regulation 359/09:37.1 and 37.2). The siting of wind turbines within 120 m of the outer edge of waterfowl nesting habitat located in a provincially significant northern wetland or elsewhere should be avoided. This distance is measured from the edge of the habitat to the tip of the turbine blade when it is rotated toward the habitat (as opposed to from the base of the turbine). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Eckhart Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Construction of turbine pads and permanent access roads in waterfowl nesting habitat will physically destroy the affected habitat. Access roads can also present a barrier to the movement of broods from nesting to rearing habitat. The best mitigation option is to avoid developing in the habitat.

When complete avoidance of the habitat is not possible, and the SWH is very large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; 2) placing it at an edge; and 3) placing it where nest density is lowest. Edge placement will maximize the amount of undisturbed habitat and minimize the barrier effect. Schedule construction and regular maintenance to occur in the fall or winter, when waterfowl are not nesting in the habitat. Leave a visual barrier of natural vegetation between the development and the habitat to reduce the effects of human disturbance on nesting birds. Ensure that the construction process does not introduce sediment into the habitat, and keep equipment and machinery off the habitat that is to be retained. Signage and a public education campaign may help workers understand the unique characteristics of waterfowl nesting habitat, and the value of leaving it undisturbed.

Even with these mitigation measures in place, developing within waterfowl nesting habitat (even when it is very large) will damage the feature and reduce its ecological function. It may be possible to at least partly compensate for these losses by enhancing the quality of the retained upland habitat (e.g., seeding to create areas of dense cover, adding nest boxes for cavity-nesting species, etc.), with a view to attracting more nesting pairs to the undisturbed portions of the habitat. For guidance on how to enhance upland waterfowl nesting habitat, consult with the Ontario Ministry of Natural Resources and/or Ducks Unlimited Canada.

Grasslands in nesting habitat should never be mowed during the nesting season.

A water balance study should be conducted for any development proposed within or adjacent to waterfowl nesting habitat to ensure no negative effects to the associated wetland. Manage stormwater from the development to ensure that there are no changes to the quality or quantity of water in the water body or wetland associated with the nesting habitat.

Development on lands adjacent to waterfowl nesting habitat requires careful site planning. Ideally, buffers of 250 m should be maintained between the development and the edge of the waterfowl nesting habitat; buffers narrower than this can act as ecological traps for nesting waterfowl (and other wildlife species). Narrower buffers may succeed in attracting waterfowl to the area, but provide insufficient protection from predators. Where possible, buffers of natural upland habitat even larger than 250 m should be established. If these areas must be developed, there may be opportunity to reconstruct (or establish) nesting habitat in other areas away from development. Reconstruction would involve establishing large areas (i.e., 4 to 10 ha) of upland grassland habitat that is connected to the wetland. The growth of native wet meadow (sedges, rushes, etc.) and grassland plants should be encouraged. Steps should be taken to prevent the invasion of nesting habitat by trees. Tallgrass prairie species such as Big Bluestem, Indian Grass, and Switchgrass provide excellent nesting habitat. The species information in the Appendix, along with the associated references, may be used to create nesting habitat for target waterfowl species.

Human disturbance effects of developments on lands adjacent to waterfowl nesting habitat can be minimized by leaving a visual barrier of vegetation between the habitat and the development. Schedule construction and regular maintenance activities to occur when birds are not using the habitat (July through March). A water balance study should be conducted for any development proposed on lands adjacent to waterfowl nesting habitat to ensure no negative effects to the associated wetland.

Potential Development Effects: Solar Power Facilities

Vegetation clearing in waterfowl nesting habitat represents a direct loss of habitat. Additionally, site alterations which isolate nesting habitat from wetlands pose a hazard to ducklings. Once eggs have hatched, the hen leads the ducklings to the marsh. Human activity at a project site may block the passage of broods.

The water body or marsh adjacent to upland nesting habitat is typically important foraging habitat for both adults and broods. Therefore it is important that no major alterations are made to this habitat. Potential indirect impacts on the water body or marsh are changes in water quality due to increased inputs of sediments, nutrients or contaminants (e.g., road salt), or changes in water levels due to increased runoff and/or decreased groundwater inputs. Changes in water levels or nutrient regimes will alter the pattern of vegetation distribution within wetlands and possibly species composition. This in turn can affect the ability of the site to attract nesting waterfowl.

Human activity at the project site may disturb nesting waterfowl. If disturbance is frequent, nesting may be prevented entirely and affected pairs may abandon the habitat. Predators such as raccoons, gulls, and skunks appear to be attracted to areas of human activity. These predators can kill nesting ducks and destroy eggs. If the upland nesting habitat is reduced to a thin band, virtually all production may be lost to predators.

Mitigation Options: Solar Power Facilities

Waterfowl nesting SWH extends 120 m from a wetland (> 0.5 ha), or from a wetland (> 0.5 ha) and any small wetlands (< 0.5 ha) within 120 m, or a cluster of 3 or more small wetlands (< 0.5 ha) within 120 m of eachother, where waterfowl nesting is known to occur.

No renewable energy project may be developed within or expanded into waterfowl nesting habitat located in a provincially significant southern or coastal wetland (Ontario Regulation 359/09:37.1 and 37.2). The siting of solar panel arrays within 120 m of the outer edge of waterfowl nesting habitat located in a provincially significant northern wetland or elsewhere should be avoided. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Site clearing and construction in waterfowl nesting habitat will destroy the habitat that is under the footprint of the development, and lead to increased human and predator activity. Additionally, development within waterfowl nesting habitat has the potential to form a barrier between the upland and wetland components of the habitat, blocking access to the wetland by newly hatched broods. Habitat loss and increased exposure to disturbance and predation will likely result in reduced reproductive success, and possible abandonment of the habitat, which in turn will reduce the ecological function of the retained habitat. The best mitigation option is to avoid developing in these habitats.

When complete avoidance of the habitat is not possible, and the SWH is very large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; 2) placing it at an edge; and 3) placing it where nest density is lowest. Edge placement will maximize the amount of undisturbed habitat and minimize the barrier effect.

Schedule construction to occur in the fall or winter, when waterfowl are not nesting in the habitat. Consider installing fencing around the development to keep workers and vehicles off the habitat; if fencing is used, it is very important to ensure that it does not block access to the wetland by broods from the edges of the habitat. Signage and an education campaign may help workers understand the unique characteristics of waterfowl nesting habitat, and the value of leaving it undisturbed. Grasslands in nesting habitat should never be mowed during the nesting season.

Even with these mitigation measures in place, developing within waterfowl nesting habitat (even when it is very large) will damage the feature and reduce its ecological function. It may be possible to at least partly compensate for these losses by enhancing the quality of the retained upland habitat (e.g., seeding to create areas of dense cover, adding nest boxes for cavity-nesting species, etc.), with a view to attracting more nesting pairs to the undisturbed portions of the habitat. For guidance on how to enhance upland waterfowl nesting habitat, consult with the Ontario Ministry of Natural Resources and/or Ducks Unlimited Canada.

A water balance study should be conducted for any development proposed within or adjacent to waterfowl nesting habitat to ensure no negative effects to the associated wetland. Manage stormwater from the development to ensure that there are no changes to the quality or quantity of water in the water body or wetland associated with the nesting habitat.

Development on lands adjacent to waterfowl nesting habitat requires careful site planning. Ideally, buffers of 250 m should be maintained between the development and the edge of the waterfowl nesting habitat; buffers narrower than this can act as ecological traps for nesting waterfowl (and other wildlife species). Narrower buffers may succeed in attracting waterfowl to the area, but provide insufficient protection from predators attracted to the area by the development. Where possible, buffers of natural upland habitat even larger than 250 m should be established. If these areas must be developed, there may be opportunity to reconstruct (or establish) nesting habitat in other areas away from development. Reconstruction would involve establishing large areas (i.e., 4 to 10 ha) of upland grassland habitat that is connected to the wetland. The growth of native wet meadow (sedges, rushes, etc.) and grassland plants should be encouraged. Steps should be taken to prevent the invasion of nesting habitat by trees. Tallgrass prairie species such as Big Bluestem, Indian Grass, and Switchgrass provide excellent nesting habitat. The species information in the Appendix, along with the associated references, may be used to create nesting habitat for target waterfowl species.

For developments adjacent to waterfowl nesting habitat, human disturbance effects can be minimized by ensuring that access roads are routed away from nesting habitat. Leave a visual barrier of natural vegetation between the development and the habitat. Consider installing fencing around the development to exclude people and vehicles; if fencing is used, it is very important to ensure that it does not block access to the wetland by broods from the edges of the habitat. Signage and an education campaign may help people understand the unique characteristics of waterfowl nesting habitat, and the value of leaving it undisturbed.

The density of cavity-nesting birds can often be increased through provision of nest boxes. This should only be done if a commitment to maintaining the boxes can be made.

ROAD DEVELOPMENT

Potential Development Effects

Roads built between the marsh and nesting habitat present difficulties for broods moving to wetlands. If traffic is heavy, road mortality of ducklings is possible. Hens may try to direct their broods around barriers like roads and buildings etc. This leaves ducklings exposed to predators for longer periods of time, reducing their chances of survival.

Roads may also affect the quality of the water body or wetland that is the focus of the waterfowl nesting habitat.

Roads can act as a barrier to surface and ground water flows thus resulting in higher water levels on one side and lower on the other. Surface water from roads may also contain sediments, high nutrient concentrations, and a variety of contaminants.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Waterfowl nesting SWH extends 120 m from a wetland (> 0.5 ha), or from a wetland (> 0.5 ha) and any small wetlands (< 0.5 ha) within 120 m, or a cluster of 3 or more small wetlands (< 0.5 ha) within 120 m of eachother, where waterfowl nesting is known to occur.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Site clearing, excavation and filling for road construction in waterfowl nesting habitat will destroy the affected habitat, and lead to increased disturbance and exposure to predation for nesting waterfowl. Additionally, roads through waterfowl nesting habitat have the potential to form a barrier between the upland and wetland components of the habitat, blocking access to the wetland by newly hatched broods. Habitat loss and increased exposure to disturbance and predation will likely result in reduced reproductive success, and possible abandonment of the habitat, which in turn will reduce the ecological function of the retained habitat. The best mitigation option is to avoid developing in these habitats.

When complete avoidance of the habitat is not possible, and the SWH is very large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; 2) placing it at an edge; and 3) placing it where nest density is lowest. Edge placement will maximize the amount of undisturbed habitat and minimize the barrier effect.

Schedule construction to occur in the fall or winter, when waterfowl are not nesting in the habitat. The construction area needs to be fenced off prior to and during construction to ensure that no equipment or heavy machinery enters the part of the nesting habitat that will be retained. If fencing is used, it is very important to ensure that it does not block access to the wetland by broods from the edges of the habitat. No herbicides should be used along the roadside to control vegetation. Roadsides should be planted in native vegetation, and mowing should be done outside the breeding season. Consideration should be given to using de-icing compounds other than salt on roads along the edge or adjacent to waterfowl nesting habitat.

A water balance study should be conducted for any development proposed within or adjacent to waterfowl nesting habitat to ensure no negative effects to the associated wetland. Sufficient culverts should be installed so that the road is not a barrier to surface water or shallow groundwater flow. If the road is likely to contribute unacceptable amounts of contaminants to the wetland, surface runoff from the road should be directed to a stormwater management facility before it reaches the wetland.

Even with these mitigation measures in place, developing within waterfowl nesting habitat (even when it is very large) will damage the feature and reduce its ecological function. It may be possible to at least partly compensate for these losses by enhancing the quality of the retained upland habitat (e.g., seeding to create areas of dense cover, adding nest boxes for cavity-nesting species, etc.), with a view to attracting more nesting pairs to the undisturbed portions of the habitat. For guidance on how to enhance upland waterfowl nesting habitat, consult with the Ontario Ministry of Natural Resources and/or Ducks Unlimited Canada.

INDEX #26: BALD EAGLE AND OSPREY NESTING, FORAGING AND PERCHING HABITAT

Ecoregions:	All of Ontario
Species Group:	Raptors (Wetlands, Lakes, Ponds, Rivers): Osprey, Bald Eagle (SPECIAL CONCERN)
Significant Wildlife Habitat Category:	Rare or Specialized Habitat
Functional Habitat:	Nesting, Foraging and Perching Habitat

DEVELOPMENT TYPES IN THIS INDEX

Osprey
Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development
Bald Eagle
Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Osprey

Ospreys use shoreline habitat for nesting, perching, roosting and foraging. Nests are almost always associated with large lakes or marshes (Penak 1983) and profitable foraging areas must be within 10 km of the nest (Poole 1989; Houston and Scott 2001). Breeding can occur in any forest ecosites that are directly adjacent (<120m) to riparian areas: streams, rivers, lakes, ponds and wetlands. Ospreys typically maintain one or more alternate nests, which may be adjacent to active nests or more than 1 km away. Most Ontario nests have been in mixed forest habitat, but nests also occur in coniferous and deciduous stands (Peck and James 1983).

Nests are usually built in large trees near shore or over water. Occasionally, nests are situated in dry habitat 1 km or more from water. Artificial nesting structures, including hydro transmission poles, may also be used. Nests are reused and become extremely large as new material is added each year. Remoteness from human disturbances may be an important parameter in the selection of nest sites for most birds, although some select sites in areas of relatively high human activity.

For breeding habitat to be functional for Osprey, there must not only be suitable nesting trees present, but also suitable perching and roosting sites. Ospreys appear to require at least one perch or roost site near occupied nests. Ospreys generally roost alone, and prefer to roost in open areas (e.g., bare branches of tall trees; large logs on mudflats; channel markers) but will roost in trees with leaves if sufficiently open. They will also roost on the ground, especially in cold, windy weather when individuals undoubtedly find a thermal advantage in doing so. Males generally have a preferred roost near the nest, used for feeding and loafing (Poole et al. 2002).

Ospreys are fish-eating birds, and productive areas of open water or deep-water marshes are required to supply fish in the quantities needed by these birds to feed growing young. The species needs clear, productive, shallow water for fishing, and requires a good view of the foraging area. Osprey feed primarily on bottom-feeding fish weighing 150 to 300 g which are caught by diving into water that is less than 1 m deep (Swenson 1979). Large lakes, rivers, and marshes with extensive shallow areas are required for foraging. Key or significant feeding areas are sites that are used throughout the breeding season by Osprey.

Bald Eagle

Bald Eagles use shoreline habitat for nesting, perching, roosting and foraging. During the breeding season, significant habitat includes the nest site, feeding areas, and trees regularly used for perching. Nests are almost always associated with lakes and rivers (OMNR 1987) and profitable foraging areas must be within 10 km of the nest (Poole 1989; Houston and Scott 2001). Lakes with <5 km of shoreline are not used unless there is a larger lake within 1 km (Brownell and Oldham 1984). This species shows a distinct preference for islands because they have often not been burned or logged (OMNR 1987) and offer many large trees suitable for nests (James 1984a); islands may also provide sites less disturbed by human activity. Breeding can occur in any forest ecosites that are directly adjacent (<120m) to riparian areas: streams, rivers, lakes, ponds and wetlands.

In the highest density breeding areas of NW Ontario, Bald Eagles show a clear preference for white pine dominant coniferous/mixed forests for nesting. Forest structure is also important. Bald Eagles nest in mature or old-growth forest with discontinuous or open canopy, usually where there is 20 to 50% crown coverage (Gerrard et al. 1975; Haywood and Ohmart 1983; Peterson 1986). The nest tree must provide an unobstructed view and flight path in all directions (Brownell and Oldham 1984); as such, Bald Eagles typically nest in "super canopy" trees (i.e., taller than their neighbours). Bald Eagles also require snags, or a number of tall dead, partially dead or living trees for perching, usually within 400 m of a nest tree (James 1984a; Caton et al. 1992). Nests are added to each year and may be used for decades. Alternate nests may also be built and used in alternate years. These nests are usually close to each other, but may be as far apart as 5 km (Stocek and Pearce 1981; Brownell and Oldham 1984).

For large fish-eating birds like the Bald Eagle, only water bodies or marshes which produce abundant fish populations or which are located near other bodies of water providing good fishing will function as nesting, perching and foraging habitat. Prime or significant foraging areas for bald eagle are those areas that are used throughout the breeding season. Proximity of nests and perch sites are important factors influencing the suitability of water bodies as foraging habitat. Bald Eagles prefer clear, productive, shallow water for fishing (although they can adapt to less clear, tannin stained water), and they require a good view of the foraging area. They prefer to hunt on large lakes with extensive shallow areas.

A high percentage of fishing occurs where water is <6 m deep 50 m from shore (Caton et al. 1992). The Bald Eagle hunts from a perch using a "sit and watch" behaviour, so the presence of suitable perches is essential. Preferred perches are on a shoreline near a productive feeding area, and with an unobstructed view and flight path. Significant perches associated with nesting habitats are those used throughout the breeding season multiple times by the nesting pair of bald eagles.

Communal roosting has been widely reported for Bald Eagles. Communal roosts may serve an information-exchange function related to the locations of the best foraging sites. Some individuals may use daytime foraging perches as night roosts. Sunning has been documented for nestlings; in cold climates, nestlings may share warmth by body contact (Beuhler 2000).

See the Appendix of species descriptions for more habitat details about the Osprey and Bald Eagle.

Potential Development Effects and Mitigation Options

Development which affects shoreline woodlands or marshes is likely to affect nesting Ospreys and Bald Eagles and possibly eagle roosting sites. Impacts include disturbance related to human activity associated with the development, habitat loss and direct mortality of individual birds. When development is proposed near habitat for Osprey and Bald Eagle, the literature should be reviewed to determine what mitigation measures are necessary. It may also be necessary to discuss options with the Ministry of Natural Resources. In some cases, it may be possible to conduct site-specific monitoring to determine the birds' reaction to different activities.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Osprey

Potential Development Effects

Lot clearing and infrastructure development that results in a loss of forest cover along shorelines may impair or eliminate the site's function as a nesting area if mature trees are removed. The loss of trees already being used by Ospreys (nest sites, perches) may result in birds abandoning the area rather that nesting in other nearby trees. In some cases, there may be no other suitable trees available. Even where site preparation retains mature trees, clearing of surrounding timber may increase the risk of blowdown for the remaining trees. Forest thinning around nest trees, roosting and perch trees puts these critical habitat components at risk.

Ospreys nesting in areas already occupied by people tend to become habituated to their presence (Poole et al. 2002), but sudden increases in disturbance such as occur on the holiday weekend in May often result in nest failure (Swenson 1979; Van Daele and Van Daele 1982; Penak 1983). Ospreys nesting in isolated areas are less tolerant of human activity.

Prime fishing areas for Osprey often are excellent angling areas. Use of habitual fishing areas by anglers may result in avoidance of these areas by Ospreys, or they may be restricted in the times that the sites are available to them. Boating also has the potential to disturb birds. Any decline in fishing success affects the rate of delivery of food to nestlings and reproductive success.

In Wyoming, Swenson (1979) found that fishermen caused a 90% decline in the number of Osprey nests and that nests over 1 km from a campsite had greater nesting success. He concluded that boating was not a problem but humans using the shoreline disturbed Ospreys. The study did not state how close humans came to active nests. The study area was located in a wilderness area as opposed to an area where humans were regularly present.

Development on lands adjacent to wetlands being used as nesting sites may have little impact on their function, provided they do not increase human activity in the area. The response of Ospreys to human disturbance depends on the distance of the development from the significant habitat, the types of activities that may occur, and the level of Osprey habituation to human activity.

Any factors that adversely affect fish productivity can also have adverse effects on Osprey. This could include increased angler harvest, or sedimentation from construction activity. Wetlands are often the most productive fish habitat in lakes; they can be affected by changes in water levels, water-level fluctuations, and/or water quality.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The active nest and a 300 m radius around the nest or the contiguous woodland stand is the SWH. This distance incorporates the nest, key perch trees, and key foraging areas. Smaller or larger setbacks may be appropriate depending on the birds' tolerance for human disturbance, on the type of disturbance likely to occur (e.g., pedestrian traffic as opposed to moving vehicular traffic), and on the intensity of the disturbance (i.e., frequency and duration).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Lot clearing and infrastructure development that results in a loss of forest cover in Osprey nesting SWH will damage or destroy the ecological function of the habitat if mature trees are removed. The best mitigation is to avoid developing in the habitat.

Development needs to minimize disturbance, since Ospreys are relatively intolerant of human disturbance while nesting and feeding. This is particularly true if development is planned for wilderness areas where there is as yet little to no human activity. The response of Osprey to human disturbance varies depending upon previous experience with human activity, the type and occurrence of those activities, and whether the activities are visible from the nest or perch, or if they are screened from view (Poole et al. 2002). In some areas where habituation has occurred (e.g., Osprey nesting next to a road or in an active transmission corridor), site-specific guidelines for setbacks may be developed based on occurrence of existing nests to human disturbances. The sequence of events is also important; developments that are well established before the birds take up residence in the spring will have less impact. Whether the Osprey are habituated to humans or not, proponents need to demonstrate that the proposed development is unlikely to displace Osprey.

Construction activity should never occur during the critical breeding period, defined as April 15 to August 31 for northwest and northeast OMNRF Regions, and April 1 to August 15 for that portion of southern OMNRF Region that is within the Area of Undertaking (OMNR 2008a). In eco-regions 6E and 7E, the breeding period will be slightly earlier. This period includes both nesting and rearing periods. Knowledge of local breeding phenology should be used to refine these dates. Appropriate sediment and contaminant control measures should be implemented during construction to ensure that disturbed soils and other materials do not enter the habitat.

Mitigating the effects of development on shoreline Osprey nesting habitat needs to consider impacts to fish populations and increased human activity within the offshore area or wetland. This may involve an evaluation of the resource capacity that will determine the level of sustainable development. Large-scale development in or immediately adjacent to Osprey nesting habitat is unlikely to be compatible with retention of the habitat.

Osprey nesting, foraging and perching SWH includes key feeding areas. These areas are less sensitive than nest sites, but are still critical to the birds. The recommended setback from significant feeding areas is 300 m. However, if the development is fairly intensive, additional buffers may be required. The development of large cottage lot or residential subdivisions, or increased human access through development on undeveloped lakes or lakes currently at capacity, can have a significant impact on fish stocks. For low-key developments such as a single cottage, proponents may be able to demonstrate that it is possible to develop closer than these guidelines without having adverse impacts (e.g., if the birds are habituated to human disturbance by other development that is closer to the habitat than the proposed development).

Bald Eagle

Potential Development Effects

Lot clearing and infrastructure development that results in a loss of forest cover along shorelines may impair or eliminate the site's function as a nesting area if mature trees are removed. The loss of trees already being used by raptors (nest sites, perches) may result in birds abandoning the area rather than nesting in other nearby trees. In some cases, there may be no other suitable trees available. Even where site preparation retains mature trees, clearing of surrounding timber may increase the risk of blowdown for the remaining trees. Forest thinning around nest trees, roosting and perch trees puts these critical habitat components at risk.

Bald Eagle sensitivity to disturbance may vary with the nesting cycle. Birds disturbed early may desert the nest (Brownell and Oldham 1984), but those disturbed after incubation is well advanced tend to finish nesting. Some eagles become habituated, but most are susceptible to disturbance (Broley 1947; Brownell and Oldham 1984; Kennedy and McTaggart-Cowan 1998). Cottage lot development often results in a decline in nesting density and in eagles nesting farther than normal from the shoreline. The distance of nests from water may increase with increasing cottage density (Lake of the Woods excepted). Low-density cottages may be tolerated at distances of 1.2 km, while nests tend to be 1.8 km away from medium- and high-density cottage developments (Gerrard et al. 1985; Peterson 1986). The farther away nests are from water, the more energy adults have to expend in supplying food to the nestlings, and reproductive success may decline. Birds displaced from nesting at the shoreline may not be able to find other suitable nest sites.

Grier et al. (2002) concluded that, for Bald Eagles, human disturbance was a complex issue that was important to consider, but not necessarily a serious problem for population status or the welfare of the birds. This was based on the authors' extensive experience at Lake of the Woods in northwestern Ontario, where there are numerous examples of successful nesting in close proximity to human habitation, boat traffic, and recreational activity. The authors stated that proximity of human activity that is tolerated by nesting eagles depended in part upon timing, with the most sensitive period early in the year, i.e., from the time the birds return to the nest site through incubation and the first week after hatch. At Lake of the Woods, successful nests have been literally over cabins, boat channels, and other areas of frequent human use (most commonly after construction). Human activity in this area, however, usually occurs later in the year. The authors cautioned that specific qualitative data were required on the subject of setbacks from eagle nests.

Prime fishing areas for Bald Eagles often are excellent angling areas. Use of habitual fishing areas by anglers may result in avoidance of these areas by eagles, or they may be restricted in the times that the sites are available to them. Boating also has the potential to disturb foraging birds. Any decline in fishing success affects rate of delivery of food to nestlings and reproductive success. On the other hand, some eagles may benefit from angler activities by scavenging leavings (e.g., fish gut piles) and taking injured released fish.

Grubb et al. (1992) studied nesting eagles' responses to various types of disturbance in Michigan. Seventy-five percent of alert and flight responses occurred when activity was 500 and 200 m away, respectively. Median response distance was 500 m for all-terrain vehicles, 200 m for automobiles, 250 m for pedestrians, 45 m for anglers, 100 m for boats, and 50 m for canoes. In Florida, Wood (1999) concluded that eagles were habituated to boats. The average flush distance was 35 m and there were no noticeable impacts upon behaviour. At Voyogeurs National Park in Minnesota, Grubb et al. (2002) reported that watercraft elicited alert or flight responses from nesting Bald Eagles 82% of the time at 85 m, 61% of the time at 86 - 172 m, 44% of the time at 173 - 335 m, and 31% of the time at 336 - 800 m. The duration of the disturbance, the number of disturbances per hour, and time of day also affected response behaviour.

McGarigal et al. (1991) studied the responses of foraging eagles to boat traffic in Washington and Oregon. Birds foraging in flight stayed about 400 m away from stationary boats. Perched birds were less disturbed and allowed approach to 100 to 200 m. Stationary boats were avoided more than moving boats. Only 27.3% of eagles flushed when a boat approached within 100 m. Some eagles shifted their activity centres to avoid boats and one pair stayed 800 to 900 m away from an experimental stationary boat. The authors recommended a buffer from boat traffic of 400 to 800 m in high-use foraging areas.

Stalmaster and Kaiser (1998) established mean flushing distances of feeding or perched eagles in Washington for various activities: a bank angler and perching eagle, 201 m; a bank angler and a feeding or standing eagle, 293 m; a hiker and a perched eagle, 183 m; a hiker and a feeding or standing eagle, 263 m; a canoe and a perching eagle, 150 m; and a canoe and a standing eagle, 250 m. The authors concluded that: a 300-m buffer would result in 95% of perched birds not flushing due to foot traffic; a 350-m buffer would prevent flushing of 95% of feeding or standing birds; 98% of birds will tolerate a low level of human activity within 350 m; and only 50% of eagles tolerate disturbances at distances of 150 m. This study was done on a wintering population as opposed to during the breeding season. Nesting eagles may be less tolerant of human disturbance than wintering birds, so more conservative (larger) setbacks may be appropriate for Bald Eagle nesting habitat.

Development on lands adjacent to wetlands or water bodies being used as nesting sites may have little impact on their function, depending on the distance of the development from the significant habitat (foraging, roosting, flight paths), the types of activity that may occur, and the level of eagle habituation to human disturbance.

Any factors that adversely affect fish productivity can also have adverse effects on Bald Eagles. This could include increased angler harvest, or sedimentation from construction activity. Wetlands are often the most productive fish habitat in lakes; they can be affected by changes in water levels, water-level fluctuations, and/or water quality.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The active nest and a 400-800 m radius around the nest or the contiguous woodland stand is the SWH. The area of the habitat (from 400 m to 800 m) depends on site lines between the nest and the development, and includes the nest, key perch trees, and key foraging areas. Smaller or larger setbacks may be appropriate depending on the birds' tolerance for human disturbance, on the type of disturbance likely to occur (e.g., pedestrian traffic as opposed to moving vehicular traffic), and on the intensity of the disturbance (i.e., frequency and duration).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Lot clearing and infrastructure development that results in a loss of forest cover in Bald Eagle nesting SWH will damage or destroy the ecological function of the habitat if mature trees are removed. The best mitigation is to avoid developing in the habitat.

Development needs to minimize disturbance, since Bald Eagles are relatively intolerant of human disturbance while nesting and feeding. This is particularly true if development is planned for wilderness areas where there is as yet little to no human activity. In some areas where habituation has occurred (e.g., nesting next to a road or in an active transmission corridor), site-specific guidelines for setbacks may be developed based on occurrence of existing nests to human disturbances. The sequence of events is also important; developments that are well established before the birds take up residence in the spring will have less impact. Whether the subject Bald Eagles are habituated to humans or not, proponents need to demonstrate that the proposed development is unlikely to displace the birds.

Construction activity should never occur during the critical breeding period, defined as March 5 to August 31 for northwest and northeast OMNRF Regions, and February 15 to August 15 for that portion of southern OMNRF Region that is within the Area of Undertaking (OMNR 2008a). In eco-regions 6E and 7E, the breeding period will be slightly earlier. This period includes both nesting and rearing periods. Knowledge of local breeding phenology should be used to refine these dates. Appropriate sediment and contaminant control measures should be implemented during construction to ensure that disturbed soils and other materials do not enter the habitat.

OMNR (1987) recommended three buffer zones around active Bald Eagle nests. The primary zone is a buffer of 100 m where no activity is permitted other than management to improve conditions for eagles. The secondary buffer extends 200 m from the nest and prohibits activities that result in significant changes in the landscape. The tertiary buffer extends 400 m from the nest but may extend 800 m from the nest if there is a direct line of sight from the nest to the activity. Anthony and Issacs (1989) recommended that human activities be restricted within 800 m of an active eagle nest.

Mitigating the effects of development on shoreline Bald Eagle nesting habitat needs to consider impacts to fish populations and increased human activity within the offshore area or wetland. This may involve an evaluation of the resource capacity that will determine the level of sustainable development. Large-scale development in or immediately adjacent to Bald Eagle nesting habitat is unlikely to be compatible with retention of the habitat.

Bald Eagle nesting, foraging and perching SWH includes key feeding areas. These areas are less sensitive than nest sites, but are still critical to the birds. Setbacks from significant feeding areas of 400 – 800 m are suggested for Bald Eagles (McGarigal et al. 1991), but 300 m has also been suggested by the Guelph District of OMNRF (Timmerman and Halyk 2001). However, if the development is fairly intensive, additional buffers may be required. Development near key feeding areas has the potential to impact eagles by affecting fish stocks and/or through disturbance from human activity. The development of large cottage lot or residential subdivisions, or increased human access through development on undeveloped lakes or lakes currently at capacity, can have a significant impact on fish stocks. For low-key developments such as a single cottage, proponents may be able to demonstrate that it is possible to develop closer than these guidelines without having adverse impacts (e.g., if the birds are habituated to human disturbance by other development that is closer to the habitat than the proposed development). For these situations, is important to consider the cumulative impact of disturbance on the birds when determining appropriate setback distances.

Proponents need to identify all perching and roosting trees. These trees should always be protected and a buffer area established around them. The extent of buffer required is likely to vary depending on the nature of the perch site, and specific habitat features that it overlooks, and the distance to the actual foraging area and associated flight paths to feeding areas. Since a high proportion of food may be obtained by kleptoparasitism (stealing food from other bird species) and scavenging, not all perches may be situated near active fishing areas. Unless it can be demonstrated that closer activity will be tolerated, a setback of 300 m is recommended from perches (Stalmaster and Kaiser 1998; Timmerman and Halyk 2001).

MAJOR RECREATIONAL DEVELOPMENT

Osprey

Potential Development Effects

Major recreational developments such as golf courses, marinas, ski resorts, and ATV/dirt bike courses have the potential to adversely affect Osprey nesting and foraging habitat.

Clearing and infrastructure development that results in a loss of forest cover along shorelines may impair or eliminate the site's function as a nesting area if mature trees are removed. The loss of trees already being used by Ospreys (nest sites, perches) may result in birds abandoning the area rather that nesting in other nearby trees. In some cases, there may be no other suitable trees available. Even where site preparation retains mature trees, clearing of surrounding timber may increase the risk of blowdown for the remaining trees. Forest thinning around nest trees, roosting and perch trees puts these critical habitat components at risk.

Ospreys nesting in areas already occupied by people tend to become habituated to their presence (Poole et al. 2002), but sudden increases in disturbance such as occur on the holiday weekend in May often result in nest failure (Swenson 1979; Van Daele and Van Daele 1982; Penak 1983). Ospreys nesting in isolated areas are less tolerant of human activity.

Prime fishing areas for Osprey often are excellent angling areas. Use of habitual fishing areas by anglers may result in avoidance of these areas by Ospreys, or they may be restricted in the times that the sites are available to them. Boating also has the potential to disturb birds. Any decline in fishing success affects the rate of delivery of food to nestlings and reproductive success.

In Wyoming Swenson (1979) found that fishermen caused a 90% decline in the number of Osprey nests and that nests over 1 km from a campsite had greater nesting success. He concluded that boating was not a problem but humans using the shoreline disturbed Ospreys. The study did not state how close humans came to active nests. The study area was located in a wilderness area as opposed to an area where humans were regularly present.

Development on lands adjacent to wetlands being used as nesting sites may have little impact on their function, provided they do not increase human activity in the area. The response of Ospreys to human disturbance depends on the distance of the development from the significant habitat, the types of activities that may occur, and the level of Osprey habituation to human activity.

Any factors that adversely affect fish productivity can also have adverse effects on Osprey. This could include increased angler harvest, or sedimentation from construction activity. Wetlands are often the most productive fish habitat in lakes; they can be affected by changes in water levels, water-level fluctuations, and/or water quality.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The active nest and a 300 m radius around the nest or the contiguous woodland stand is the SWH. This distance incorporates the nest, key perch trees, and key foraging areas. Smaller or larger setbacks may be appropriate depending on the birds' tolerance for human disturbance, on the type of disturbance likely to occur (e.g., pedestrian traffic, vehicular traffic, boats), and on the intensity of the disturbance (i.e., frequency and duration).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and infrastructure development that results in a loss of forest cover in Osprey nesting SWH will damage or destroy the ecological function of the habitat if mature trees are removed. The best mitigation is to avoid developing in the habitat.

Development needs to minimize disturbance, since Ospreys are relatively intolerant of human disturbance while nesting and feeding. This is particularly true if development is planned for wilderness areas where there is as yet little to no human activity. The response of Osprey to human disturbance varies depending upon previous experience with human activity, the type and occurrence of those activities, and whether the activities are visible from the nest or perch, or if they are screened from view (Poole et al. 2002). In some areas where habituation has occurred (e.g., Osprey nesting next to a road or in an active transmission corridor), site-specific guidelines for setbacks may be developed based on occurrence of existing nests to human disturbances. The sequence of events is also important; developments that are well established before the birds take up residence in the spring will have less impact. Whether the subject Osprey are habituated to humans or not, proponents need to demonstrate that the proposed development is unlikely to displace Osprey.

When designing a golf course or golf course community, a buffer area should always be retained along water bodies, especially if they are being used for nesting or foraging by Ospreys. This will leave key nest trees and perches intact and will also provide a visual barrier to activity on the golf course or within the community.

Construction activity should never occur during the critical breeding period, defined as April 15 to August 31 for northwest and northeast OMNRF Regions, and April 1 to August 15 for that portion of southern OMNRF Region that is within the Area of Undertaking (OMNR 2008a). In eco-regions 6E and 7E, the breeding period will be slightly earlier. This period includes both nesting and rearing periods. Knowledge of local breeding phenology should be used to refine these dates. Appropriate sediment and contaminant control measures should be implemented during construction to ensure that disturbed soils and other materials do not enter the habitat.

Mitigating the effects of development on shoreline Osprey nesting habitat needs to consider impacts to fish populations and increased human activity within the offshore area or wetland. This may involve an evaluation of the resource capacity that will determine the level of sustainable development. Large-scale development in or immediately adjacent to Osprey nesting habitat is unlikely to be compatible with retention of the habitat.

Osprey nesting, foraging and perching SWH includes key feeding areas. These areas are less sensitive than nest sites, but are still critical to the birds. The recommended setback from significant feeding areas is 300 m. However, if the development is fairly intensive, additional buffers may be required.

Bald Eagle

Potential Development Effects

Major recreational developments such as golf courses, marinas, ski resorts, and AVT/dirt bike courses have the potential to adversely affect Bald Eagle nesting and foraging habitat.

Clearing and infrastructure development that results in a loss of forest cover along shorelines may impair or eliminate the site's function as a nesting area if mature trees are removed. The loss of trees already being used by Bald Eagles (nest sites, perches) may result in birds abandoning the area rather that nesting in other nearby trees. In some cases, there may be no other suitable trees available. Even where site preparation retains mature trees, clearing of surrounding timber may increase the risk of blowdown for the remaining trees. Forest thinning around nest trees, roosting and perch trees puts these critical habitat components at risk.

Bald Eagle sensitivity to disturbance may vary with the nesting cycle. Birds disturbed early may desert the nest (Brownell and Oldham 1984), but those disturbed after incubation is well advanced tend to finish nesting. Some eagles become habituated, but most are susceptible to disturbance (Broley 1947; Brownell and Oldham 1984; Kennedy and McTaggart-Cowan 1998). The farther away nests are from water, the more energy adults have to expend in supplying food to the nestlings, and reproductive success may decline. Birds displaced from nesting at the shoreline may not be able to find other suitable nest sites.

Grier et al. (2002) concluded that, for Bald Eagles, human disturbance was a complex issue that was important to consider, but not necessarily a serious problem for population status or the welfare of the birds. This was based on the authors' extensive experience at Lake of the Woods in northwestern Ontario, where there are numerous examples of successful nesting in close proximity to human habitation, boat traffic, and recreational activity. The authors stated that proximity of human activity that is tolerated by nesting eagles depended in part upon timing, with the most sensitive period early in the year, i.e., from the time the birds return to the nest site through incubation and the first week after hatch. At Lake of the Woods, successful nests have been literally over cabins, boat channels, and other areas of frequent human use (most commonly after construction). Human activity in this area, however, usually occurs later in the year. The authors cautioned that specific qualitative data were required on the subject of setbacks from eagle nests.

Prime fishing areas for Bald Eagles often are excellent angling areas. Use of habitual fishing areas by anglers may result in avoidance of these areas by eagles, or they may be restricted in the times that the sites are available to them. Boating also has the potential to disturb birds. Any decline in fishing success affects rate of delivery of food to nestlings and reproductive success. On the other hand, some eagles may benefit from angler activities by scavenging leavings (e.g., fish gut piles) and taking injured released fish.

Grubb et al. (1992) studied nesting eagles' responses to various types of disturbance in Michigan. Seventy-five percent of alert and flight responses occurred when activity was 500 and 200 m away, respectively. Median response distance was 500 m for all-terrain vehicles, 200 m for automobiles, 250 m for pedestrians, 45 m for anglers, 100 m for boats, and 50 m for canoes. In Florida, Wood (1999) concluded that eagles were habituated to boats. The average flush distance was 35 m and there were no noticeable impacts upon behaviour. At Voyogeurs National Park in Minnesota, Grubb et al. (2002) reported that watercraft elicited alert or flight responses from nesting Bald Eagles 82% of the time at 85 m, 61% of the time at 86 - 172 m, 44% of the time at 173 - 335 m, and 31% of the time at 336 - 800 m. The duration of the disturbance, the number of disturbances per hour, and time of day also affected response behaviour.

McGarigal et al. (1991) studied the responses of foraging eagles to boat traffic in Washington and Oregon. Birds foraging in flight stayed about 400 m away from stationary boats. Perched birds were less disturbed and allowed approach to 100 to 200 m. Stationary boats were avoided more than moving boats. Only 27.3% of eagles flushed when a boat approached within 100 m. Some eagles shifted their activity centres to avoid boats and one pair stayed 800 to 900 m away from an experimental stationary boat. The authors recommended a buffer from boat traffic of 400 to 800 m in high-use foraging areas.

Stalmaster and Kaiser (1998) established mean flushing distances of feeding or perched eagles in Washington for various activities: a bank angler and perching eagle, 201 m; a bank angler and a feeding or standing eagle, 293 m; a hiker and a perched eagle, 183 m; a hiker and a feeding or standing eagle, 263 m; a canoe and a perching eagle, 150 m; and a canoe and a standing eagle, 250 m. The authors concluded that: a 300-m buffer would result in 95% of perched birds not flushing due to foot traffic; a 350-m buffer would prevent flushing of 95% of feeding or standing birds; 98% of birds will tolerate a low level of human activity within 350 m; and only 50% of eagles tolerate disturbances at distances of 150 m. This study was done on a wintering population as opposed to during the breeding season. Nesting eagles may be less tolerant of human disturbance than wintering birds, so more conservative (larger) setbacks may be appropriate for Bald Eagle nesting habitat.

Development on lands adjacent to wetlands or water bodies being used as nesting sites may have little impact on their function, depending on the distance of the development from the significant habitat (foraging, roosting, flight paths), the types of activity that may occur, and the level of eagle habituation to human disturbance.

Any factors that adversely affect fish productivity can also have adverse effects on Bald Eagles. This could include increased angler harvest, or sedimentation from construction activity. Wetlands are often the most productive fish habitat in lakes; they can be affected by changes in water levels, water-level fluctuations, and/or water quality.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The active nest and a 400-800 m radius around the nest or the contiguous woodland stand is the SWH. The area of the habitat (from 400 m to 800 m) depends on site lines between the nest and the development, and includes the nest, key perch trees, and key foraging areas. Smaller or larger setbacks may be appropriate depending on the birds' tolerance for human disturbance, on the type of disturbance likely to occur (e.g., pedestrian traffic as opposed to moving vehicular traffic), and on the intensity of the disturbance (i.e., frequency and duration).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and infrastructure development that results in a loss of forest cover in Bald Eagle nesting SWH will damage or destroy the ecological function of the habitat if mature trees are removed. The best mitigation is to avoid developing in the habitat.

When designing recreational developments, a buffer area should always be retained along water bodies, especially if they are being used for nesting or foraging by Bald Eagles. This will leave key nest trees and perches intact and will also provide a visual barrier to activity on the golf course or within the community. This option may not adequately mitigate impacts where large-scale forest clearing is planned, e.g., golf course development.

Development needs to minimize disturbance, since Bald Eagles are relatively intolerant of human disturbance while nesting and feeding. This is particularly true if development is planned for wilderness areas where there is as yet little to no human activity. In some areas where habituation has occurred (e.g., nesting next to a road or in an active transmission corridor), site-specific guidelines for setbacks may be developed based on occurrence of existing nests to human disturbances. The sequence of events is also important; developments that are well established before the birds take up residence in the spring will have less impact. Whether the subject Bald Eagles are habituated to humans or not, proponents need to demonstrate that the proposed development is unlikely to displace the birds.

Construction activity should never occur during the critical breeding period, defined as March 5 to August 31 for northwest and northeast OMNRF Regions, and February 15 to August 15 for that portion of southern OMNRF Region that is within the Area of Undertaking (OMNR 2008a). In eco-regions 6E and 7E, the breeding period will be slightly earlier. This period includes both nesting and rearing periods. Knowledge of local breeding phenology should be used to refine these dates. Appropriate sediment and contaminant control measures should be implemented during construction to ensure that disturbed soils and other materials do not enter the habitat.

OMNR (1987) recommended three buffer zones around active Bald Eagle nests. The primary zone is a buffer of 100 m where no activity is permitted other than management to improve conditions for eagles. The secondary buffer extends 200 m from the nest and prohibits activities that result in significant changes in the landscape. The tertiary buffer extends 400 m from the nest but may extend 800 m from the nest if there is a direct line of sight from the nest to the activity. Anthony and Issacs (1989) recommended that human activities be restricted within 800 m of an active eagle nest.

Mitigating the effects of development on shoreline Bald Eagle nesting habitat needs to consider impacts to fish populations and increased human activity within the offshore area or wetland. This may involve an evaluation of the resource capacity that will determine the level of sustainable development. Large-scale development in or immediately adjacent to Bald Eagle nesting habitat is unlikely to be compatible with retention of the habitat.

Bald Eagle nesting, foraging and perching SWH includes key feeding areas. These areas are less sensitive than nest sites, but are still critical to the birds. Setbacks from significant feeding areas of 400 – 800 m are suggested for Bald Eagles (McGarigal et al. 1991), but 300 m has also been suggested by the Guelph District of OMNRF (Timmerman and Halyk 2001). However, if the development is fairly intensive, additional buffers may be required. Development near key feeding areas has the potential to impact eagles by affecting fish stocks and/or through disturbance from human activity. Major recreational developments that are likely to increase angler activity (e.g., marinas), especially on undeveloped lakes or lakes currently at capacity, can have a significant impact on fish stocks. For recreational developments unlikely to increase angler activity (e.g., golf courses), proponents may be able to demonstrate that it is possible to develop closer than these guidelines without having adverse impacts (e.g., if the birds are habituated to human disturbance by other development that is closer to the habitat than the proposed development). For these situations, is important to consider the cumulative impact of disturbance on the birds when determining appropriate setback distances.

Proponents need to identify all perching and roosting trees. These trees should always be protected and a buffer area established around them. The extent of buffer required is likely to vary depending on the nature of the perch site, and specific habitat features that it overlooks, and the distance to the actual foraging area and associated flight paths to feeding areas. Since a high proportion of food may be obtained by kleptoparasitism (stealing food from other bird species) and scavenging, not all perches may be situated near active fishing areas. Unless it can be demonstrated that closer activity will be tolerated, a setback of 300 m is recommended from perches (Stalmaster and Kaiser 1998; Timmerman and Halyk 2001).

AGGREGATE AND MINE DEVELOPMENT

Osprey

Potential Development Effects

Mineral exploration and mine development have the potential to affect Osprey nesting and foraging habitat. In northwestern Ontario, mineral exploration is occurring on the shores of lakes; where mine development occurs, it is expected to have an impact on Osprey. It is also possible that sand and gravel pits could be established in areas adjacent to Osprey nests.

Clearing and infrastructure development that results in a loss of forest cover along shorelines may impair or eliminate the site's function as a nesting area if mature trees are removed. The loss of trees already being used by Ospreys (nest sites, perches) may result in birds abandoning the area rather that nesting in other nearby trees. In some cases, there may be no other suitable trees available.

Ospreys nesting in areas already occupied by people tend to become habituated to their presence (Poole et al. 2002), but sudden increases in disturbance often result in nest failure (Swenson 1979; Van Daele and Van Daele 1982; Penak 1983). Ospreys nesting in isolated areas are less tolerant of human activity.

Development on lands adjacent to wetlands being used as nesting sites may have little impact on their function, provided they do not increase human activity in the area. The response of Ospreys to human disturbance depends on the distance of the development from the significant habitat, the types of activities that may occur, and the level of Osprey habituation to human activity.

Any factors that adversely affect fish productivity can also have adverse effects on Osprey, e.g., sedimentation from construction activity, or polluted runoff from the project site. Wetlands are often the most productive fish habitat in lakes; they can be affected by changes in water levels, water-level fluctuations, and/or water quality.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The active nest and a 300 m radius around the nest or the contiguous woodland stand is the SWH. This distance incorporates the nest, key perch trees, and key foraging areas. Smaller or larger setbacks may be appropriate depending on the birds' tolerance for human disturbance, on the type of disturbance likely to occur (e.g., blasting), and on the intensity of the disturbance (i.e., frequency and duration).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and infrastructure development that results in a loss of forest cover in Osprey nesting SWH will damage or destroy the ecological function of the habitat if mature trees are removed. The best mitigation is to avoid developing in the habitat.

Development needs to minimize disturbance, since Ospreys are relatively intolerant of human disturbance while nesting and feeding. This is particularly true if development is planned for wilderness areas where there is as yet little to no human activity. The response of Osprey to human disturbance varies depending upon previous experience with human activity, the type and occurrence of those activities, and whether the activities are visible from the nest or perch, or if they are screened from view (Poole et al. 2002). In some areas where habituation has occurred (e.g., Osprey nesting next to a road or in an active transmission corridor), site-specific guidelines for setbacks may be developed based on occurrence of existing nests to human disturbances. The sequence of events is also important; developments that are well established before the birds take up residence in the spring will have less impact. Whether the subject Osprey are habituated to humans or not, proponents need to demonstrate that the proposed development is unlikely to displace Osprey.

A vegetated buffer zone should always be retained along water bodies, especially if they are being used for nesting or foraging by Ospreys. This will leave key nest trees and perches intact and will also provide a visual barrier to activity on the project site.

Construction activity should never occur during the critical breeding period, defined as April 15 to August 31 for northwest and northeast OMNRF Regions, and April 1 to August 15 for that portion of southern OMNRF Region that is within the Area of Undertaking (OMNR 2008a). In eco-regions 6E and 7E, the breeding period will be slightly earlier. This period includes both nesting and rearing periods. Knowledge of local breeding phenology should be used to refine these dates. Appropriate sediment and contaminant control measures should be implemented during construction to ensure that disturbed soils and other materials do not enter the habitat.

Osprey nesting, foraging and perching SWH includes key feeding areas. These areas are less sensitive than nest sites, but are still critical to the birds. The recommended setback from significant feeding areas is 300 m. However, if the development is fairly intensive, additional buffers may be required.

Ensure that runoff from the development does not contaminate the habitat or adjacent water bodies.

Bald Eagle

Potential Development Effects

Mineral exploration and mine development have the potential to affect Bald Eagle nesting and foraging habitat. In northwestern Ontario, mineral exploration is occurring on the shores of lakes; where mine development occurs, it is expected to have an impact on Bald Eagles. It is also possible that sand and gravel pits could be established in areas adjacent to Bald Eagle nests.

Clearing and infrastructure development that results in a loss of forest cover along shorelines may impair or eliminate the site's function as a nesting area if mature trees are removed. The loss of trees already being used by Bald Eagles (nest sites, perches) may result in birds abandoning the area rather that nesting in other nearby trees. In some cases, there may be no other suitable trees available.

All development brings with it increased human activity. In the case of aggregate and mine projects, there is a potential for short-term, intense disturbance during construction, and for ongoing disturbance from extraction and hauling activity. Bald Eagle sensitivity to disturbance may vary with the nesting cycle. Birds disturbed early may desert the nest (Brownell and Oldham 1984), but those disturbed after incubation is well advanced tend to finish nesting. Some eagles become habituated, but most are susceptible to disturbance (Broley 1947; Brownell and Oldham 1984; Kennedy and McTaggart-Cowan 1998). The farther away nests are from water, the more energy adults have to expend in supplying food to the nestlings, and reproductive success may decline. Birds displaced from nesting at the shoreline may not be able to find other suitable nest sites.

Grier et al. (2002) concluded that, for Bald Eagles, human disturbance was a complex issue that was important to consider, but not necessarily a serious problem for population status or the welfare of the birds. This was based on the authors' extensive experience at Lake of the Woods in northwestern Ontario, where there are numerous examples of successful nesting in close proximity to human habitation, boat traffic, and recreational activity. The authors stated that proximity of human activity that is tolerated by nesting eagles depended in part upon timing, with the most sensitive period early in the year, i.e., from the time the birds return to the nest site through incubation and the first week after hatch. At Lake of the Woods, successful nests have been literally over cabins, boat channels, and other areas of frequent human use (most commonly after construction). Human activity in this area, however, usually occurs later in the year. The authors cautioned that specific qualitative data were required on the subject of setbacks from eagle nests.

Grubb et al. (1992) studied nesting eagles' responses to various types of disturbance in Michigan. Seventy-five percent of alert and flight responses occurred when activity was 500 and 200 m away, respectively. Median response distance was 500 m for all-terrain vehicles, 200 m for automobiles, and 250 m for pedestrians. The duration of the disturbance, the number of disturbances per hour, and time of day also affect response behaviour (Grubb et al. 2002).

Development on lands adjacent to wetlands or water bodies being used as nesting sites may have little impact on their function, depending on the distance of the development from the significant habitat (foraging, roosting, flight paths), the types of activity that may occur, and the level of eagle habituation to human disturbance.

Any factors that adversely affect fish productivity will have adverse effects on Bald Eagles. Indirect effects may potentially occur from changes in water quality that affect fish populations in lakes where eagles forage, e.g., sedimentation, or contamination by polluted runoff. Wetlands are often the most productive fish habitat in lakes. They could be affected by changes in water levels or water-level fluctuations.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The active nest and a 400-800 m circular area around the nest or the contiguous woodland stand is the SWH. The area of the habitat (from 400 m to 800 m) depends on site lines between the nest and the development, and includes the nest, key perch trees, and key foraging areas. Smaller or larger setbacks may be appropriate depending on the birds' tolerance for human disturbance, on the type of disturbance likely to occur (e.g., pedestrian traffic as opposed to moving vehicular traffic), and on the intensity of the disturbance (i.e., frequency and duration).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and infrastructure development that results in a loss of forest cover in Bald Eagle nesting SWH will damage or destroy the ecological function of the habitat if mature trees are removed. The best mitigation is to avoid developing in the habitat.

A vegetated buffer zone should always be retained along water bodies, especially if they are being used for nesting or foraging by Bald Eagles. This will leave key nest trees and perches intact and will also provide a visual barrier to activity on the project site. This option may not adequately mitigate impacts where large-scale forest clearing is planned.

Development needs to minimize disturbance, since Bald Eagles are relatively intolerant of human disturbance while nesting and feeding. This is particularly true if development is planned for wilderness areas where there is as yet little to no human activity. In some areas where habituation has occurred (e.g., nesting next to a road or in an active transmission corridor), site-specific guidelines for setbacks may be developed based on occurrence of existing nests to human disturbances. The sequence of events is also important; developments that are well established before the birds take up residence in the spring will have less impact. Whether the Bald Eagles are habituated to humans or not, proponents need to demonstrate that the proposed development is unlikely to displace the birds.

Construction activity should never occur during the critical breeding period, defined as March 5 to August 31 for northwest and northeast OMNRF Regions, and February 15 to August 15 for that portion of southern OMNRF Region that is within the Area of Undertaking (OMNR 2008a). In eco-regions 6E and 7E, the breeding period will be slightly earlier. This period includes both nesting and rearing periods. Knowledge of local breeding phenology should be used to refine these dates. Appropriate sediment and contaminant control measures should be implemented during construction to ensure that disturbed soils and other materials do not enter the habitat.

The United States Fish and Wildlife Service (USFWS 2007) recommends that activities that produce extremely loud noise (e.g., blasting) be avoided within 800 m of an active Bald Eagle nest, unless greater tolerance to the activity (or similar activity) has been demonstrated by the eagles nesting in the area.

OMNR (1987) recommended three buffer zones around active Bald Eagle nests. The primary zone is a buffer of 100 m where no activity is permitted other than management to improve conditions for eagles. The secondary buffer extends 200 m from the nest and prohibits activities that result in significant changes in the landscape. The tertiary buffer extends 400 m from the nest but may extend 800 m from the nest if there is a direct line of sight from the nest to the activity. Anthony and Issacs (1989) recommended that human activities be restricted within 800 m of an active eagle nest.

Bald Eagle nesting, foraging and perching SWH includes key feeding areas. These areas are less sensitive than nest sites, but are still critical to the birds. Setbacks from significant feeding areas of 400 – 800 m are suggested for Bald Eagles (McGarigal et al. 1991), but 300 m has also been suggested by the Guelph District of OMNRF (Timmerman and Halyk 2001). For example, where development is proposed in already developed areas (i.e., the birds are habituated to human activity), proponents may be able to demonstrate that it is possible to develop closer than these guidelines without having adverse impacts (e.g., if there is other development closer to the habitat than the proposed development). For these situations, it is important to consider the cumulative impact of disturbance on the birds when determining appropriate setback distances.

Proponents need to identify all perching and roosting trees. These trees should always be protected and a buffer area established around them. The extent of buffer required is likely to vary depending on the nature of the perch site, and specific habitat features that it overlooks, and the distance to the actual foraging area and associated flight paths to feeding areas. Since a high proportion of food may be obtained by kleptoparasitism (stealing food from other bird species) and scavenging, not all perches may be situated near active fishing areas. Unless it can be demonstrated that closer activity will be tolerated, a setback of 300 m is recommended from perches (Stalmaster and Kaiser 1998; Timmerman and Halyk 2001).

Ensure that runoff from the development does not contaminate the habitat or adjacent water bodies.

ENERGY DEVELOPMENT

Osprey

Potential Development Effects: Wind Power Facilities

Despite the environmental benefits associated with wind energy, considerable controversy has accompanied the development of wind power facilities and their effects on birds. The main adverse effects of wind power facilities on raptors are mortality through collision with turbine blades and other structures, and displacement of foraging birds as a result of disturbance at the project site (Fielding et al. 2006; Madders and Whitfield 2006). Displacement effectively results in the loss of foraging and breeding habitat (Fielding et al. 2006). Human activity at the project site also has the potential to disturb nesting, perching and foraging Osprey.

Few long-term studies have been conducted on the impacts of wind power facilities on birds, and the focus has been on collision rather than disturbance (Kingsley and Whittam 2005). In terms of disturbance effects, early evidence suggests that habitat loss through displacement may be occurring. In a Norwegian study, the number of White-tailed Eagle pairs holding territories within 500 m of a wind farm site fell from 13 pre-construction to only 5 at 4 years post-construction (Nygard et al. 2010), suggesting displacement of the missing pairs. Additionally, at the wind power site in Wisconsin, raptor abundance was reduced 47% post-construction compared to pre-construction levels (Garvin et al. 2010). The authors concluded that this decline may have been a result of displacement due to the disturbance of wind farm construction and the ongoing presence of turbines and maintenance machinery. Another study in Wisconsin (Howe et al. 2002, in Garvin et al. 2010) found that open-country raptors were more abundant in the reference area surrounding the subject wind farm than within the wind farm study area. Displacement has not been studied at the Californian Wind Resource Areas (Whitfield 2009). On the other hand, there was no evidence of Golden Eagle displacement at Foote Creek Rim, Wyoming (Johnson et al. 2000, in Whitfield 2009. Lack of displacement means little indirect habitat loss, but it also means that the birds are at risk by venturing into the environs of operating turbines.

All development brings with it increased human activity. In the case of a renewable energy project, there is a potential for short-term, intense disturbance during construction, and for ongoing disturbance through regular maintenance activity. Ospreys nesting in areas already occupied by people tend to become habituated to their presence (Poole et al. 2002), but sudden increases in disturbance often result in nest failure (Swenson 1979; Van Daele and Van Daele 1982; Penak 1983). Ospreys nesting in isolated areas are less tolerant of human activity.

Diurnal raptors (e.g., eagles, buteos, accipiters, Northern Harrier, Osprey, falcons, and Turkey Vultures) appear to be particularly susceptible to being killed by striking turbine blades at wind power facilities. Bird vulnerability and mortality reflects a combination of site-specific (wind-relief interaction), species-specific and seasonal factors (Barrios and Rodríguez 2004). Raptors are more likely to collide with turbine blades than many other avian species due to their morphology and foraging behaviour (e.g., heavy wing loading, focus on distant prey (Janss 2000; Kikuchi 2008)). High mortality rates have been documented in California and at Tarifa and Navarre in Spain (Kingsley and Whittam 2005). At Altamount Pass and Tehachapi Pass in California, most raptor deaths were recorded during the winter when the birds were hunting for mammalian prey (Kingsley and Whittam 2005). Drewitt and Langston (2008) stated that certain birds of prey have good binocular vision but poor peripheral vision, which might explain why they run into transmission wires and turbine blades. Negative impacts on Osprey using a nesting area will, in turn, have a negative impact on the habitat itself by reducing its ecological function as a nesting area.

The most important factor that influences turbine-related mortality for raptors appears to be topography. Landform features such as elevation, ridges and slopes are likely very important in determining the amount of raptor mortality in areas where raptors are abundant (Anderson et al. 2000, in Kingsley and Whittam 2005). Higher elevations and complex terrain (many ridges and slopes) appear to coincide with greater raptor mortality than lower elevations and simpler terrain.

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Site preparation that includes the clearing of nest trees or roost/perch trees results in the direct loss of habitat for breeding Osprey.

Any factors that adversely affect fish productivity can also have adverse effects on Osprey, e.g., sedimentation from construction activity, or contaminated runoff from the project site. Wetlands are often the most productive fish habitat in lakes; they can be affected by changes in water levels, water-level fluctuations, and/or water quality.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the edge of Osprey nesting, foraging and perching SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The SWH includes the active nest plus a 300 m radius around the nest or the contiguous woodland stand. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for the construction of turbine pads, access roads and other project components in Osprey nesting SWH will damage or destroy the affected habitat, especially if mature trees are removed. The best mitigation option is to avoid developing in the habitat.

Development needs to minimize disturbance, since Ospreys are relatively intolerant of human disturbance while nesting and feeding. This is particularly true if development is planned for wilderness areas where there is as yet little to no human activity. The response of Osprey to human disturbance varies depending upon previous experience with human activity, the type and occurrence of those activities, and whether the activities are visible from the nest or perch, or if they are screened from view (Poole et al. 2002). In some areas where habituation has occurred (e.g., Osprey nesting next to a road or in an active transmission corridor), site-specific guidelines for setbacks may be developed based on occurrence of existing nests to human disturbances. The sequence of events is also important; developments that are well established before the birds take up residence in the spring will have less impact. Whether the Osprey are habituated to humans or not, proponents need to demonstrate that the proposed development is unlikely to displace Osprey.

Construction activity should never occur during the critical breeding period, defined as April 15 to August 31 for northwest and northeast OMNRF Regions, and April 1 to August 15 for that portion of southern OMNRF Region that is within the Area of Undertaking (OMNR 2008a). In eco-regions 6E and 7E, the breeding period will be slightly earlier. This period includes both nesting and rearing periods. Knowledge of local breeding phenology should be used to refine these dates. Appropriate sediment and contaminant control measures should be implemented during construction to ensure that disturbed soils and other materials do not enter the habitat.

Models of bird distribution at several spatial scales can be used to circumvent potential difficulties when locating turbines (Madders and Whitfield 2006). Additionally, information about the movement patterns of Osprey in the project area, as determined during the Natural Heritage Assessment for Renewable Energy Projects, will be critical to designing the most appropriate layout for a wind power facility. Turbines should be situated where they will not interfere with the movement of Osprey between nests, perches, and key foraging areas. Choose sites with the lowest levels of Osprey activity. Careful siting of turbines should adequately mitigate Osprey mortality due to collision with rotating blades.

Osprey nesting, foraging and perching SWH includes key feeding areas. These areas are less sensitive than nest sites, but are still critical to the birds. The recommended setback from significant feeding areas is 300 m. However, if the development is fairly intensive, additional buffers may be required.

Ensure that runoff from the development does not contaminate the habitat or adjacent water bodies.

Potential Development Effects: Solar Power Facilities

Vegetation clearing and development that results in a loss of forest cover along shorelines may impair or eliminate the site's function as a nesting area if mature trees are removed. The loss of trees already being used by Ospreys (nest sites, perches) may result in birds abandoning the area rather that nesting in other nearby trees. In some cases, there may be no other suitable trees available.

All development brings with it increased human activity. In the case of a renewable energy project, there is a potential for short-term, intense disturbance during construction, and for ongoing disturbance through regular maintenance activity. Ospreys nesting in areas already occupied by people tend to become habituated to their presence (Poole et al. 2002), but sudden increases in disturbance often result in nest failure (Swenson 1979; Van Daele and Van Daele 1982; Penak 1983). Ospreys nesting in isolated areas are less tolerant of human activity.

Development on lands adjacent to wetlands being used as nesting sites may have little impact on their function, provided they do not increase human activity in the area. This depends on the distance of the development from the significant habitat and the types of activity that may occur.

Any factors that adversely affect fish productivity can also have adverse effects on Osprey. This could include increased angler harvest, or sedimentation from construction activity. Wetlands are often the most productive fish habitat in lakes; they can be affected by changes in water levels, water-level fluctuations, and/or water quality.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of the edge of Osprey nesting, foraging and perching SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The SWH includes the active nest plus a 300 m radius around the nest or the contiguous woodland stand. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Large-scale vegetation clearing in Osprey nesting, foraging and perching habitat will physically destroy the habitat. Disturbance associated with human activity at the project location has the potential to reduce the ecological function of retained habitat. The best mitigation option is to avoid developing in the habitat.

Development needs to minimize disturbance, since Ospreys are relatively intolerant of human disturbance while nesting and feeding. This is particularly true if development is planned for wilderness areas where there is as yet little to no human activity. The response of Osprey to human disturbance varies depending upon previous experience with human activity, the type and occurrence of those activities, and whether the activities are visible from the nest or perch, or if they are screened from view (Poole et al. 2002). In some areas where habituation has occurred (e.g., Osprey nesting next to a road or in an active transmission corridor), site-specific guidelines for setbacks may be developed based on occurrence of existing nests to human disturbances. Whether the Osprey are habituated to humans or not, proponents need to demonstrate that the proposed development is unlikely to displace Osprey.

Construction activity should never occur during the critical breeding period, defined as April 15 to August 31 for northwest and northeast OMNRF Regions, and April 1 to August 15 for that portion of southern OMNRF Region that is within the Area of Undertaking (OMNR 2008a). In eco-regions 6E and 7E, the breeding period will be slightly earlier. This period includes both nesting and rearing periods. Knowledge of local breeding phenology should be used to refine these dates. Appropriate sediment and contaminant control measures should be implemented during construction to ensure that disturbed soils and other materials do not enter the habitat.

Osprey nesting, foraging and perching SWH includes key feeding areas. These areas are less sensitive than nest sites, but are still critical to the birds. The recommended setback from significant feeding areas is 300 m. However, if the development is fairly intensive, additional buffers may be required.

Ensure that runoff from the development does not contaminate the habitat or adjacent water bodies.

Bald Eagle

Potential Development Effects: Wind Power Facilities

Despite the environmental benefits associated with wind energy, considerable controversy has accompanied the development of wind power facilities and their effects on birds. The main adverse effects of wind power facilities on raptors are mortality through collision with turbine blades and other structures, and displacement of foraging birds as a result of disturbance at the project site (Fielding et al. 2006; Madders and Whitfield 2006). Displacement effectively results in the loss of foraging and breeding habitat (Fielding et al. 2006).

Few long-term studies have been conducted on the impacts of wind power facilities on birds, and the focus has been on collision rather than disturbance (Kingsley and Whittam 2005). In terms of disturbance effects, early evidence suggests that habitat loss through displacement may be occurring. In a Norwegian study, the number of White-tailed Eagle pairs holding territories within 500 m of a wind farm site fell from 13 pre-construction to only 5 at 4 years post-construction (Nygard et al. 2010), suggesting displacement of the missing pairs. Additionally, at the wind power site in Wisconsin, raptor abundance was reduced 47% post-construction compared to pre-construction levels (Garvin et al. 2010). The authors concluded that this decline may have been a result of displacement due to the disturbance of wind farm construction and the ongoing presence of turbines and maintenance machinery. Another study in Wisconsin (Howe et al. 2002, in Garvin et al. 2010) found that open-country raptors were more abundant in the reference area surrounding the subject wind farm than within the wind farm study area. Displacement has not been studied at the Californian Wind Resource Areas (Whitfield 2009). On the other hand, there was no evidence of Golden Eagle displacement at Foote Creek Rim, Wyoming (Johnson et al. 2000, in Whitfield 2009. Lack of displacement means little indirect habitat loss, but it also means that the birds are at risk by venturing into the environs of operating turbines.

All development brings with it increased human activity. In the case of a renewable energy project, there is a potential for short-term, intense disturbance during construction, and for ongoing disturbance through regular maintenance activity. Bald Eagle sensitivity to disturbance may vary with the nesting cycle. Birds disturbed early may desert the nest (Brownell and Oldham 1984), but those disturbed after incubation is well advanced tend to finish nesting. Some eagles become habituated, but most are susceptible to disturbance (Broley 1947; Brownell and Oldham 1984; Kennedy and McTaggart-Cowan 1998). Development near shorelines can displace nesting Eagles to areas further removed from the water. The farther away nests are from water, the more energy adults have to expend in supplying food to the nestlings, and reproductive success may decline. Birds displaced from nesting at the shoreline may not be able to find other suitable nest sites.

Grier et al. (2002) concluded that, for Bald Eagles, human disturbance was a complex issue that was important to consider, but not necessarily a serious problem for population status or the welfare of the birds. This was based on the authors' extensive experience at Lake of the Woods in northwestern Ontario, where there are numerous examples of successful nesting in close proximity to human habitation, boat traffic, and recreational activity. The authors stated that proximity of human activity that is tolerated by nesting eagles depended in part upon timing, with the most sensitive period early in the year, i.e., from the time the birds return to the nest site through incubation and the first week after hatch. At Lake of the Woods, successful nests have been literally over cabins, boat channels, and other areas of frequent human use (most commonly after construction). Human activity in this area, however, usually occurs later in the year. The authors cautioned that specific qualitative data were required on the subject of setbacks from eagle nests.

Grubb et al. (1992) studied nesting eagles' responses to various types of disturbance in Michigan. Seventy-five percent of alert and flight responses occurred when activity was 500 and 200 m away, respectively. Median response distance was 500 m for all-terrain vehicles, 200 m for automobiles, and 250 m for pedestrians. The duration of the disturbance, the number of disturbances per hour, and time of day also affect response behaviour (Grubb et al. 2002).

Diurnal raptors (e.g., eagles, buteos, accipiters, Northern Harrier, Osprey, falcons, and Turkey Vultures) appear to be particularly susceptible to being killed by striking turbine blades at wind power facilities. Bird vulnerability and mortality reflects a combination of site-specific (wind-relief interaction), species-specific and seasonal factors (Barrios and Rodríguez 2004). Raptors are more likely to collide with turbine blades than many other avian species due to their morphology and foraging behaviour (e.g., heavy wing loading, focus on distant prey (Janss 2000; Kikuchi 2008)). High mortality rates have been documented in California and at Tarifa and Navarre in Spain (Kingsley and Whittam 2005). At Altamount Pass and Tehachapi Pass in California, most raptor deaths were recorded during the winter when the birds were hunting for mammalian prey (Kingsley and Whittam 2005). Drewitt and Langston (2008) stated that certain birds of prey have good binocular vision but poor peripheral vision, which might explain why they run into transmission wires and turbine blades. Negative impacts on Bald Eagles using a nesting area will, in turn, have a negative impact on the habitat itself by reducing its ecological function as a nesting area.

The most important factor that influences turbine-related mortality for raptors appears to be topography. Landform features such as elevation, ridges and slopes are likely very important in determining the amount of raptor mortality in areas where raptors are abundant (Anderson et al. 2000, in Kingsley and Whittam 2005). Higher elevations and complex terrain (many ridges and slopes) appear to coincide with greater raptor mortality than lower elevations and simpler terrain.

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Site preparation that includes the clearing of nest trees or roost/perch trees results in the direct loss of habitat for breeding Bald Eagles.

Any factors that adversely affect fish productivity can also have adverse effects on Bald Eagles. This could include sedimentation from construction activity, or pollution of aquatic habitats by contaminated runoff from the project site. Wetlands are often the most productive fish habitat in lakes; they can be affected by changes in water levels, water-level fluctuations, and/or water quality.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the edge of Bald Eagle nesting, foraging and perching SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The active nest and a 400-800 m radius around the nest or the contiguous woodland stand is the SWH. The area of the habitat (from 400 m to 800 m) depends on site lines between the nest and the development, and includes the nest, key perch trees, and key foraging areas. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for the construction of turbine pads, access roads and other project components in Bald Eagle nesting SWH will damage or destroy the affected habitat, especially if mature trees are removed. The best mitigation option is to avoid developing in the habitat.

Development needs to minimize disturbance, since Bald Eagles are relatively intolerant of human disturbance while nesting and feeding. This is particularly true if development is planned for wilderness areas where there is as yet little to no human activity. In some areas where habituation has occurred (e.g., nesting next to a road or in an active transmission corridor), site-specific guidelines for setbacks may be developed based on occurrence of existing nests to human disturbances. The sequence of events is also important; developments that are well established before the birds take up residence in the spring will have less impact. Whether the Bald Eagles are habituated to humans or not, proponents need to demonstrate that the proposed development is unlikely to displace the birds.

Construction activity should never occur during the critical breeding period, defined as March 5 to August 31 for northwest and northeast OMNRF Regions, and February 15 to August 15 for that portion of southern OMNRF Region that is within the Area of Undertaking (OMNR 2008a). In eco-regions 6E and 7E, the breeding period will be slightly earlier. This period includes both nesting and rearing periods. Knowledge of local breeding phenology should be used to refine these dates. Appropriate sediment and contaminant control measures should be implemented during construction to ensure that disturbed soils and other materials do not enter the habitat.

The United States Fish and Wildlife Service (USFWS 2007) recommends that activities that produce extremely loud noise (e.g., blasting) be avoided within 800 m of an active Bald Eagle nest, unless greater tolerance to the activity (or similar activity) has been demonstrated by the eagles nesting in the area.

OMNR (1987) recommended three buffer zones around active Bald Eagle nests. The primary zone is a buffer of 100 m where no activity is permitted other than management to improve conditions for eagles. The secondary buffer extends 200 m from the nest and prohibits activities that result in significant changes in the landscape. The tertiary buffer extends 400 m from the nest but may extend 800 m from the nest if there is a direct line of sight from the nest to the activity. Anthony and Issacs (1989) recommended that human activities be restricted within 800 m of an active eagle nest.

Bald Eagle nesting, foraging and perching SWH includes key feeding areas. These areas are less sensitive than nest sites, but are still critical to the birds. Setbacks from significant feeding areas of 400 – 800 m are suggested for Bald Eagles (McGarigal et al. 1991), but 300 m has also been suggested by the Guelph District of OMNRF (Timmerman and Halyk 2001). For example, where development is proposed in already developed areas (i.e., the birds are habituated to human activity), proponents may be able to demonstrate that it is possible to develop closer than these guidelines without having adverse impacts (e.g., if there is other development closer to the habitat than the proposed development). For these situations, it is important to consider the cumulative impact of disturbance on the birds when determining appropriate setback distances. Where development is proposed adjacent to undeveloped lakes (i.e., the birds are not habituated to human activity), larger setbacks should be considered.

Proponents need to identify all perching and roosting trees. These trees should always be protected and a buffer area established around them. The extent of buffer required is likely to vary depending on the nature of the perch site, and specific habitat features that it overlooks, and the distance to the actual foraging area and associated flight paths to feeding areas. Since a high proportion of food may be obtained by kleptoparasitism (stealing food from other bird species) and scavenging, not all perches may be situated near active fishing areas. Unless it can be demonstrated that closer activity will be tolerated, a setback of 300 m is recommended from perches (Stalmaster and Kaiser 1998; Timmerman and Halyk 2001).

Models of bird distribution at several spatial scales can be used to circumvent potential difficulties when locating turbines (Madders and Whitfield 2006). Additionally, information about the movement patterns of Bald Eagles in the project area, as determined during the Natural Heritage Assessment for Renewable Energy Projects, will be critical to designing the most appropriate layout for a wind power facility. Turbines should be situated where they will not interfere with the movement of eagles between nests, perches, and key foraging areas. Choose sites with the lowest levels of eagle activity. Careful siting of turbines should adequately mitigate Bald Eagle mortality due to collision with rotating blades.

Potential Development Effects: Solar Power Facilities

Vegetation clearing and development that results in a loss of forest cover along shorelines may impair or eliminate the site's function as a nesting area if mature trees are removed. The loss of trees already being used by Eagles (nest sites, perches) may result in birds abandoning the area rather that nesting in other nearby trees. In some cases, there may be no other suitable trees available.

All development brings with it increased human activity. In the case of a renewable energy project, there is a potential for short-term, intense disturbance during construction, and for ongoing disturbance through regular maintenance activity. Bald Eagle sensitivity to disturbance may vary with the nesting cycle. Birds disturbed early may desert the nest (Brownell and Oldham 1984), but those disturbed after incubation is well advanced tend to finish nesting. Some eagles become habituated, but most are susceptible to disturbance (Broley 1947; Brownell and Oldham 1984; Kennedy and McTaggart-Cowan 1998). Development near shorelines can displace nesting Eagles to areas further removed from the water. The farther away nests are from water, the more energy adults have to expend in supplying food to the nestlings, and reproductive success may decline. Birds displaced from nesting at the shoreline may not be able to find other suitable nest sites.

Grier et al. (2002) concluded that, for Bald Eagles, human disturbance was a complex issue that was important to consider, but not necessarily a serious problem for population status or the welfare of the birds. This was based on the authors' extensive experience at Lake of the Woods in northwestern Ontario, where there are numerous examples of successful nesting in close proximity to human habitation, boat traffic, and recreational activity. The authors stated that proximity of human activity that is tolerated by nesting eagles depended in part upon timing, with the most sensitive period early in the year, i.e., from the time the birds return to the nest site through incubation and the first week after hatch. At Lake of the Woods, successful nests have been literally over cabins, boat channels, and other areas of frequent human use (most commonly after construction). Human activity in this area, however, usually occurs later in the year. The authors cautioned that specific qualitative data were required on the subject of setbacks from eagle nests.

Grubb et al. (1992) studied nesting eagles' responses to various types of disturbance in Michigan. Seventy-five percent of alert and flight responses occurred when activity was 500 and 200 m away, respectively. Median response distance was 500 m for all-terrain vehicles, 200 m for automobiles, 250 m for pedestrians, 45 m for anglers, 100 m for boats, and 50 m for canoes.

Development on lands adjacent to wetlands or water bodies being used as nesting sites may have little impact on their function, depending on the distance of the development from the significant habitat (foraging, roosting, flight paths), the types of activity that may occur, and the level of eagle habituation to human disturbance.

Any factors that adversely affect fish productivity can also have adverse effects on Bald Eagles. This could include increased sedimentation from construction activity, or pollution of aquatic habitats by contaminated runoff from the project site. Wetlands are often the most productive fish habitat in lakes; they can be affected by changes in water levels, water-level fluctuations, and/or water quality.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of the edge of Bald Eagle nesting, foraging and perching SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The active nest and a 400-800 m radius around the nest or the contiguous woodland stand is the SWH. The area of the habitat (from 400 m to 800 m) depends on site lines between the nest and the development, and includes the nest, key perch trees, and key foraging areas. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Large-scale vegetation clearing in Bald Eagle nesting, foraging and perching habitat will physically destroy the habitat. Disturbance associated with human activity at the project location has the potential to reduce the ecological function of retained habitat. The best mitigation option is to avoid developing in the habitat.

Development needs to minimize disturbance, since Bald Eagles are relatively intolerant of human disturbance while nesting and feeding. This is particularly true if development is planned for wilderness areas where there is as yet little to no human activity. In some areas where habituation has occurred (e.g., nesting next to a road or in an active transmission corridor), site-specific guidelines for setbacks may be developed based on occurrence of existing nests to human disturbances. The sequence of events is also important; developments that are well established before the birds take up residence in the spring will have less impact. Whether the Bald Eagles are habituated to humans or not, proponents need to demonstrate that the proposed development is unlikely to displace the birds.

Construction activity should never occur during the critical breeding period, defined as March 5 to August 31 for northwest and northeast OMNRF Regions, and February 15 to August 15 for that portion of southern OMNRF Region that is within the Area of Undertaking (OMNR 2008a). In eco-regions 6E and 7E, the breeding period will be slightly earlier. This period includes both nesting and rearing periods. Knowledge of local breeding phenology should be used to refine these dates. Appropriate sediment and contaminant control measures should be implemented during construction to ensure that disturbed soils and other materials do not enter the habitat.

The United States Fish and Wildlife Service (USFWS 2007) recommends that activities that produce extremely loud noise (e.g., blasting) be avoided within 800 m of an active Bald Eagle nest, unless greater tolerance to the activity (or similar activity) has been demonstrated by the eagles nesting in the area.

OMNR (1987) recommended three buffer zones around active Bald Eagle nests. The primary zone is a buffer of 100 m where no activity is permitted other than management to improve conditions for eagles. The secondary buffer extends 200 m from the nest and prohibits activities that result in significant changes in the landscape. The tertiary buffer extends 400 m from the nest but may extend 800 m from the nest if there is a direct line of sight from the nest to the activity. Anthony and Issacs (1989) recommended that human activities be restricted within 800 m of an active eagle nest.

Bald Eagle nesting, foraging and perching SWH includes key feeding areas. These areas are less sensitive than nest sites, but are still critical to the birds. Setbacks from significant feeding areas of 400 – 800 m are suggested for Bald Eagles (McGarigal et al. 1991), but 300 m has also been suggested by the Guelph District of OMNRF (Timmerman and Halyk 2001). For example, where development is proposed in already developed areas (i.e., the birds are habituated to human activity), proponents may be able to demonstrate that it is possible to develop closer than these guidelines without having adverse impacts (e.g., if there is other development closer to the habitat than the proposed development). For these situations, it is important to consider the cumulative impact of disturbance on the birds when determining appropriate setback distances. Where development is proposed adjacent to undeveloped lakes (i.e., the birds are not habituated to human activity), larger setbacks should be considered.

Proponents need to identify all perching and roosting trees. These trees should always be protected and a buffer area established around them. The extent of buffer required is likely to vary depending on the nature of the perch site, and specific habitat features that it overlooks, and the distance to the actual foraging area and associated flight paths to feeding areas. Since a high proportion of food may be obtained by kleptoparasitism (stealing food from other bird species) and scavenging, not all perches may be situated near active fishing areas. Unless it can be demonstrated that closer activity will be tolerated, a setback of 300 m is recommended from perches (Stalmaster and Kaiser 1998; Timmerman and Halyk 2001).

Ensure that runoff from the development does not contaminate the habitat or adjacent water bodies.

ROAD DEVELOPMENT

Osprey

Potential Development Effects

Vegetation clearing for road construction in forested habitat that supports nesting Osprey has the potential to destroy nest trees, roosts and perches.

Roads may affect Osprey nesting and foraging activities if construction activities cause undue disturbance, or if traffic noise and pedestrians along the road disturb birds.

Feeding habitat could also be affected by roads if they introduce sediments or other contaminants that have the potential to affect water clarity or fish populations.

Bridges over water in Osprey nesting habitat have the potential to cause birds to abandon habitually used feeding areas or nests and perches if the bridge is close to them. The severity of impact will depend on the type of road (heavily used highway vs. low-use side road), proximity to habitual foraging areas, the location of the road (wilderness vs. developed area), and the degree of Osprey habituation to human disturbance at the site.

Any factors that adversely affect fish productivity can also have adverse effects on Osprey. This could include increased angler harvest, sedimentation from construction activity, or pollution of the aquatic habitat by contaminated runoff (e.g., road salt, herbicides). Wetlands are often the most productive fish habitat in lakes; they can be affected by changes in water levels, water-level fluctuations, and/or water quality.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The active nest and a 300 m radius around the nest or the contiguous woodland stand is the SWH. This distance incorporates the nest, key perch trees, and key foraging areas. Smaller or larger setbacks may be appropriate depending on the birds' tolerance for human disturbance, on the type of disturbance likely to occur (e.g., pedestrian traffic as opposed to moving vehicular traffic), and on the intensity of the disturbance (i.e., traffic volume and speed).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and infrastructure development that results in a loss of forest cover in Osprey nesting SWH may damage the ecological function of the habitat if mature trees are removed. The best mitigation is to avoid developing in the habitat.

Where complete avoidance is not possible, minimize the amount of habitat affected by making the development footprint where it affects the habitat as small as possible, and by siting it at the edge where Osprey activity is lowest. Osprey movement patterns and the location of key perches and foraging habitats can be determined as part of the Natural Heritage Assessment process. This information will be critical to the appropriate routing of roads. Roads that run parallel to shorelines should be set back far enough that Osprey are unlikely to be disturbed when nesting or using perches. Maintain a visual barrier of natural vegetation between the road and the habitat.

Development needs to minimize disturbance, since Ospreys are relatively intolerant of human disturbance while nesting and feeding. This is particularly true if development is planned for wilderness areas where there is as yet little to no human activity. The response of Osprey to human disturbance varies depending upon previous experience with human activity, the type and occurrence of those activities, and whether the activities are visible from the nest or perch, or if they are screened from view (Poole et al. 2002). In some areas where habituation has occurred (e.g., Osprey nesting in an active transmission corridor), site-specific guidelines for setbacks may be developed based on occurrence of existing nests to human disturbances. The sequence of events is also important; developments that are well established before the birds take up residence in the spring will have less impact. Whether the Osprey are habituated to humans or not, proponents need to demonstrate that the proposed development is unlikely to displace Osprey.

Construction activity should never occur during the critical breeding period, defined as April 15 to August 31 for northwest and northeast OMNRF Regions, and April 1 to August 15 for that portion of southern OMNRF Region that is within the Area of Undertaking (OMNR 2008a). In eco-regions 6E and 7E, the breeding period will be slightly earlier. This period includes both nesting and rearing periods. Knowledge of local breeding phenology should be used to refine these dates. Appropriate sediment and contaminant control measures should be implemented during construction to ensure that disturbed soils and other materials do not enter the habitat.

For bridge crossings, avoid important foraging areas such as shallow rapids and areas near confluences that support diverse fish communities. Crossing at key foraging areas may result in the Ospreys avoiding these areas and thus having less food available to them.

Osprey nesting, foraging and perching SWH includes key feeding areas. These areas are less sensitive than nest sites, but are still critical to the birds. The recommended setback from significant feeding areas is 300 m. However, if the development is fairly intensive, additional buffers may be required.

Ensure that runoff from the development does not contaminate the habitat or adjacent water bodies. Design roadside drainage to maintain the pre-development water regime in adjacent aquatic habitats.

Bald Eagle

Potential Development Effects

Vegetation clearing for road construction in forested habitat that supports nesting Bald Eagles has the potential to destroy nest trees, roosts and perches.

Road construction and traffic noise may disturb nesting and foraging Bald Eagles. Although eagles are tolerant of moving vehicles, they may be disturbed by vehicles that slow down or stop. They may also be disturbed by pedestrians walking along the roadside or over bridges.

Roads are most likely to have impacts when they are in or near Bald Eagle habitat in an urban area. This is where vehicles are likely to slow due to heavy traffic or pedestrians are likely to be common. These were some of the concerns when a new arterial road system was proposed for the City of Cambridge (Timmerman and Halyk 2001).

Feeding habitat could also be affected by roads if they introduce sediments or other contaminants that have the potential to affect water clarity or fish populations.

Bridges over water in Bald Eagle nesting habitat have the potential to cause birds to abandon habitual feeding areas or nests and perches if the bridge is close to them. The severity of impact will depend on the type of road (heavily used highway vs. low-use side road), proximity to habitually used foraging areas, the location of the road (wilderness vs. developed area), and the degree of eagle habituation to human disturbance at the site.

Any factors that adversely affect fish productivity can also have adverse effects on Bald Eagles. This could include increased angler harvest, sedimentation from construction activity, or pollution of the aquatic habitat by contaminated runoff (e.g., road salt, herbicides). Wetlands are often the most productive fish habitat in lakes; they can be affected by changes in water levels, water-level fluctuations, and/or water quality.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The active nest and a 400-800 m circular area around the nest or the contiguous woodland stand is the SWH. The area of the habitat (from 400 m to 800 m) depends on site lines between the nest and the development, and includes the nest, key perch trees, and key foraging areas. Smaller or larger setbacks may be appropriate depending on the birds' tolerance for human disturbance, on the type of disturbance likely to occur (e.g., pedestrian traffic as opposed to moving vehicular traffic), and on the intensity of the disturbance (i.e., frequency and duration).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and infrastructure development that results in a loss of forest cover in Bald Eagle nesting SWH will damage or destroy the ecological function of the habitat if mature trees are removed. The best mitigation is to avoid developing in the habitat.

Where complete avoidance is not possible, minimize the amount of habitat affected by making the development footprint where it affects the habitat as small as possible, and by siting it at the edge where Bald Eagle activity is lowest. Eagle movement patterns and the location of key perches and foraging habitats can be determined as part of the Natural Heritage Assessment process. This information will be critical to the appropriate routing of roads. Roads that run parallel to shorelines should be set back far enough that eagles are unlikely to be disturbed when nesting or using perches. Maintain a visual barrier of natural vegetation between the road and the habitat.

Development needs to minimize disturbance, since Bald Eagles are relatively intolerant of human disturbance while nesting and feeding. This is particularly true if development is planned for wilderness areas where there is as yet little to no human activity. In some areas where habituation has occurred (e.g., nesting next to a road or in an active transmission corridor), site-specific guidelines for setbacks may be developed based on occurrence of existing nests to human disturbances. The sequence of events is also important; developments that are well established before the birds take up residence in the spring will have less impact. Whether the Bald Eagles are habituated to humans or not, proponents need to demonstrate that the proposed development is unlikely to displace the birds.

Construction activity should never occur during the critical breeding period, defined as March 5 to August 31 for northwest and northeast OMNRF Regions, and February 15 to August 15 for that portion of southern OMNRF Region that is within the Area of Undertaking (OMNR 2008a). In eco-regions 6E and 7E, the breeding period will be slightly earlier. This period includes both nesting and rearing periods. Knowledge of local breeding phenology should be used to refine these dates. Appropriate sediment and contaminant control measures should be implemented during construction to ensure that disturbed soils and other materials do not enter the habitat.

The United States Fish and Wildlife Service (USFWS 2007) recommends that activities that produce extremely loud noise (e.g., blasting) be avoided within 800 m of an active Bald Eagle nest, unless greater tolerance to the activity (or similar activity) has been demonstrated by the eagles nesting in the area.

For bridge crossings, avoid important foraging areas such as shallow rapids and areas near confluences that support diverse fish communities. Crossing at key foraging areas may result in the eagles avoiding these areas and thus having less food available to them.

Bald Eagle nesting, foraging and perching SWH includes key feeding areas. These areas are less sensitive than nest sites, but are still critical to the birds. The recommended setback from significant feeding areas is 300 m. However, if the development is fairly intensive, additional buffers may be required. For example, where development is proposed in already developed areas (i.e., the birds are habituated to human activity), proponents may be able to demonstrate that it is possible to develop closer than these guidelines without having adverse impacts (e.g., if there is other development closer to the habitat than the proposed development). For these situations, it is important to consider the cumulative impact of disturbance on the birds when determining appropriate setback distances. Where development is proposed adjacent to undeveloped lakes (i.e., the birds are not habituated to human activity), larger setbacks should be considered.

Ensure that runoff from the development does not contaminate the habitat or adjacent water bodies. Design roadside drainage to maintain the pre-development water regime in adjacent aquatic habitats.

INDEX #27: WOODLAND RAPTOR NESTING HABITAT

Ecoregions:	All of Ontario
Species Group:	Woodland Raptors (Woodlands): Northern Goshawk, Red-tailed Hawk, Cooper's Hawk, Sharp-shinned Hawk, Red-shouldered Hawk, Northern Saw-whet Owl, Barred Owl, Great Horned Owl, Merlin, Broad-winged Hawk
Significant Wildlife Habitat Category:	Rare or Specialized Habitat
Functional Habitat:	Nesting Habitat
Habitat Features:	Intermediate-aged to mature forests

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

The birds in this guild nest in forested habitat and hunt either in forested or adjacent open habitat. Most woodland raptors have highly specialized habitat requirements and may be vulnerable to apparently minor changes in habitat. Forests provide the cover necessary for woodland raptors to find shelter, build nests and roost. Most of the raptors in this guild also hunt for prey in the forest. These species have evolved to hunt and manoeuvre swiftly within the forest canopy and understory. Forests provide the small mammals, birds, amphibians, and reptiles these species need to feed their offspring.

Many woodland raptors are strongly territorial with individuals defending their space. It is not uncommon for them to use the same territory for a number of years. For most species, home ranges are much larger than defended territories. Even in ideal nesting habitat, nesting raptors tend to be widely spaced, seldom nesting closer than a kilometre to each other, although this varies by species. Most species in the group build new nests each year in traditional nesting areas, but some use the same nest year after year. These birds may build or repair more than one nest in their territory but they lay eggs in only one of them.

Some species in this guild have suffered from forest fragmentation across southern Ontario due to their dependence on larger tracts of continuous forest cover. Woodland raptors vary in their tolerance of human disturbance and certain species require a high degree of seclusion from most forms of human activity. Nest-site disturbance is particularly of concern owing to its impact on brood survival and hence population density and stability.

See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Development can have significant impacts on the breeding habitat of woodland raptors. Site alterations which reduce the availability of forest cover effectively remove productive habitat from the territory of resident breeding pairs. Depending on the size of the area affected and the overall availability of woodland habitat, there may be a significant reduction in the amount of food available to feed offspring. This in turn affects brood rearing success, impacting population growth and the long-term persistence of woodland raptors. Forest fragmentation or decreasing forest size can have adverse effects on species such as Northern Goshawk, Red-shouldered Hawk, and Barred Owl. All of the raptors in this guild have large home ranges and require large areas in which to hunt. Prey populations fluctuate annually, and any loss of habitat for the raptors or their prey may result in a decline of woodland raptors or their local extirpation from a forest.

Tree cutting within woodlands can reduce the habitat suitability for some raptors. Loss of mature trees may result in loss of existing or potential nest sites and perches. Tree cutting can also promote regeneration. This makes hunting much more difficult for species such as Northern Goshawk, Red-shouldered Hawk and Barred Owl. Tree cutting may also make the habitat more suitable for competitive edge species such as the Red-tailed Hawk which may displace the Red-shouldered Hawk.

Development may affect wetland habitat or woodland pools by discharge of stormwater or drying due to reduced infiltration. This can reduce prey availability for species that consume many amphibians, such as the Red-shouldered Hawk. Most raptors require more than one habitat type within their home range to satisfy their nesting and foraging needs.

Removal of dead and declining trees may result in the loss of suitable nesting cavities for some species such the three owls in this guild.

Development in the vicinity of nesting habitat may cause birds to abandon the area, particularly if development increases the level of human activity in the area. Frequent disturbance can lead to nest abandonment. Once displaced, a breeding pair will have to seek other suitable nest sites within their territory. If none exist, they will have to compete with other birds for access to suitable nesting sites. Only birds successful at defending nesting sites will breed. The end result is a reduction in nesting habitat within the area and ultimately a reduction in raptor numbers. Because the nests of most species are spaced considerable distances apart, the loss of one nesting territory probably means that one less pair will breed.

Development on adjacent lands may have considerable impact on breeding habitat if it results in an increase in human activity within the pair's territory. Intrusions into the traditional nesting habitat during the nesting season may result in birds abandoning the site. Increased human activity and site alterations which affect food availability, or which simply prevent raptors from foraging in the area, may result in a reduction of accessible food within the territory to the point that brood survival is impacted. Birds cannot switch to new feeding sites since chances are they occur within the territories of other breeding pairs, or there may be no suitable habitat nearby.

Domestic cats have the potential to compete with woodland raptors for small mammal prey (George 1974).

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes a 50 – 400 m radius of habitat around the active nest, depending on the species (see Criteria Tables for further details).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, excavation and/or filling for development in woodland raptor nesting SWH will destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible and site it at the edge of the habitat to reduce effects from habitat fragmentation. Avoid disturbing the most critical habitat areas for nesting raptors including the nest site, the territory around the nest, and key foraging areas along with habitat for the primary prey species.

Many woodland species do not adapt well to reductions in the size of forests and fragmentation of existing woodlands. Forest size and integrity need to be protected as much as possible when planning for development. Forest sizes should never be reduced below the minimum forest size requirements of the most sensitive species present. Lots spaced throughout woodlots should always be avoided. It would be better to cluster development in a few areas and preserve as much natural area as possible. Additional forested lands can be created through planting or allowing areas to grow back naturally. This is a slow process and is not suitable compensation for the loss of forest habitat since many species may be reduced to critically low numbers in the intervening time period. Local and regional extinctions may occur in the interim and new habitat may not be colonized in the future.

Mitigating the effects of development on woodland raptor breeding habitat involves preventing the loss of forest cover, maintaining the existing forest structure, and ensuring that increased human activity does not occur near nests during the nesting season.

Lot clearing and construction should always be directed as far away from existing nests as possible. Given the importance of nest sites and the way raptors use perches located in surrounding habitat, a buffer from active nests where no development is allowed may be required to prevent the loss of nesting habitat function. This is particularly important for species that tend to build new nests a distance from the previous year's nest.

James (1984a) suggested times when activity should be restricted in woodland raptor nesting areas. These restrictions were March through June for Northern Goshawk, March through July for Cooper's Hawk, April through July for Sharp-shinned Hawk, and March through July for Red-shouldered Hawk.

OMNR (2008a) provided updated forest management recommendations for woodland raptor nests. For the Northern Goshawk and Red-shouldered Hawk, a total of 28 ha of unharvested or lightly harvested mature forest should be retained as suitable nesting habitat within a radius of 400 m, and 7 ha of this suitable nesting habitat will be within 200 m of the nest. These same amounts of forested habitat need to be retained as a minimum when establishing commercial or residential development, provided that there is that much forest present initially.

The structure of the forest is extremely important to many woodland raptors. Removal of mature and decadent trees and snags should be avoided. Forest-thinning activities that are likely to promote sapling and shrub growth should always be avoided when species such as the accipiters, Red-shouldered Hawk, or Barred Owl are involved.

Appropriate stormwater management will be required to ensure that woodland pools and wetlands and the amphibians they support are not adversely affected. If these aquatic resources are dependent on groundwater, it should be demonstrated that development will not have negative impacts on groundwater quality or quantity which could ultimately affect raptor prey populations.

Many raptors are generally not very adaptable to new habitat conditions. Nonetheless, most raptor species appear to be expanding their range in Ontario based on results of the second Ontario Breeding Bird Atlas (Cadman et al. 2007). Raptors are particularly vulnerable to changes in habitat because they tend to return to the same area to nest year after year. They may do this even if the habitat has become unsuitable to the point where nesting birds do not raise a brood. In Waterloo Region, Red-shouldered Hawks continued to return to traditional nesting sites even after the forests in which they nested were reduced to areas as small as 4 ha. Eventually, the Red-shouldered Hawk was temporarily extirpated from the Region of Waterloo as these small woodland fragments were not capable of supporting self-sustaining populations, but the Red-shouldered Hawk has recently reappeared as a result of more forest cover than was present in the late 1960s and early 1970s (Campbell 1975; Sharp and Campbell 1982; Bryant 1986).

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Woodland raptor habitat could potentially be affected by golf courses and ski resorts.

Development can have significant impacts on the breeding habitat of woodland raptors. Site alterations which reduce the availability of forest cover effectively remove productive habitat from the territory of resident breeding pairs. Depending on the size of the area affected and the overall availability of woodland habitat, there may be a significant reduction in the amount of food available to feed offspring. This in turn affects brood rearing success, impacting population growth and the long-term persistence of woodland raptors. Forest fragmentation or decreasing forest size can have adverse effects on species such as Northern Goshawk, Red-shouldered Hawk, and Barred Owl. All of the raptors in this guild have large home ranges and require large areas in which to hunt. Prey populations fluctuate annually, and any loss of habitat for the raptors or their prey may result in a decline of woodland raptors or their local extirpation from a forest.

Tree cutting within woodlands can reduce the habitat suitability for some raptors. Loss of mature trees may result in loss of existing or potential nest sites and perches. Tree cutting can also promote regeneration. This makes hunting much more difficult for species such as Northern Goshawk, Red-shouldered Hawk and Barred Owl. Tree cutting may also make the habitat more suitable for competitive edge species such as the Red-tailed Hawk which may displace the Red-shouldered Hawk.

Development may affect wetland habitat or woodland pools by discharge of stormwater or drying due to reduced infiltration. This can reduce prey availability for species that consume many amphibians, such as the Red-shouldered Hawk. Most raptors require more than one habitat type within their home range to satisfy their nesting and foraging needs.

Removal of dead and decadent trees may result in the loss of suitable nesting cavities for some species such the three owls in this guild.

Development in the vicinity of nesting habitat may cause birds to abandon the area, particularly if development increases the level of human activity in the area. Frequent disturbance can lead to nest abandonment. Once displaced, a breeding pair will have to seek other suitable nest sites within their territory. If none exist, they will have to compete with other birds for access to suitable nesting sites. Only birds successful at defending nesting sites will breed. The end result is a reduction in nesting habitat within the area and ultimately a reduction in raptor numbers. Because the nests of most species are spaced considerable distances apart, the loss of one nesting territory probably means that one less pair will breed.

Development on adjacent lands may have considerable impact on breeding habitat if it results in an increase in human activity within the pair's territory. Intrusions into the traditional nesting habitat during the nesting season may result in birds abandoning the site. Increased human activity and site alterations which affect food availability, or which simply prevent raptors from foraging in the area, may result in a reduction of accessible food within the territory to the point that brood survival is impacted. Birds cannot switch to new feeding sites since chances are they occur within the territories of other breeding pairs, or there may be no suitable habitat nearby.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes a 50 – 400 m radius of habitat around the active nest, depending on the species (see Criteria Tables for further details).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, excavation and/or filling for development in woodland raptor nesting SWH will destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible and site it at the edge of the habitat to reduce effects from habitat fragmentation. Avoid disturbing the most critical habitat areas for nesting raptors including the nest site, the territory around the nest, and key foraging areas along with habitat for the primary prey species.

Many woodland species do not adapt well to reductions in the size of forests and fragmentation of existing woodlands. Forest size and integrity needs to be protected as much as possible when planning for development. Forest sizes should never be reduced below the minimum forest size requirements of the most sensitive species present. Lots spaced throughout woodlots should never be planned. It would be better to cluster development in a few areas and preserve as much natural area as possible. Additional forested lands can be created through planting or allowing areas to grow back naturally. This is a slow process and is not suitable compensation for the loss of forest habitat since many species may be reduced to critically low numbers in the intervening time period. Local and regional extinctions may occur in the interim and new habitat may not be colonized in the future.

Mitigating the effects of development on woodland raptor breeding habitat involves preventing the loss of forest cover, maintaining the existing forest structure, and ensuring that increased human activity does not occur near nests during the nesting season.

Forest cutting for fairways or ski runs should always be minimized and directed away from nesting areas. If forest clearing is essential, it should always be done as close to the existing edge of the forest as possible. This will minimize the impacts of forest fragmentation and edge effects (growth of shrubs) on breeding woodland raptors.

Construction should always be directed as far away from existing nests as possible. Given the importance of nest sites and the way raptors use perches located in surrounding habitat, a buffer from active nests where no development is allowed may be required to prevent the loss of nesting habitat function. This is particularly important for species that tend to build new nests a distance from the previous year's nest.

James (1984a) suggested times when activity should be restricted in woodland raptor nesting areas. These restrictions were March through June for Northern Goshawk, March through July for Cooper's Hawk, April through July for Sharp-shinned Hawk, and March through July for Red-shouldered Hawk.

OMNR (2008a) provided updated forest management recommendations for woodland raptor nests. For the Northern Goshawk and Red-shouldered Hawk, a total of 28 ha of unharvested or lightly harvested mature forest should be retained as suitable nesting habitat within a radius of 400 m, and 7 ha of this suitable nesting habitat will be within 200 m of the nest. These same amounts of forested habitat need to be retained as a minimum when establishing major recreational development, provided that there is that much forest present initially.

The structure of the forest is extremely important to many woodland raptors. Removal of mature and decadent trees and snags should be avoided. Forest-thinning activities that are likely to promote sapling and shrub growth should always be avoided when species such as the accipiters, Red-shouldered Hawk, or Barred Owl are involved.

Appropriate stormwater management will be required to ensure that woodland pools and wetlands and the amphibians they support are not adversely affected. If these aquatic resources are dependent on groundwater, it should be demonstrated that development will not have negative impacts on groundwater quality or quantity which could ultimately affect raptor prey populations.

Raptors are generally not very adaptable to new habitat conditions. Nonetheless, most raptor species appear to be expanding their range in Ontario based on results of the second Ontario Breeding Bird Atlas (Cadman et al. 2007). Raptors are particularly vulnerable to changes in habitat because they tend to return to the same area to nest year after year. They may do this even if the habitat has become unsuitable to the point where nesting birds do not raise a brood. In Waterloo Region, Red-shouldered Hawks continued to return to traditional nesting sites even after the forests in which they nested were reduced to areas as small as 4 ha. Eventually, the Red-shouldered Hawk was temporarily extirpated from the Region of Waterloo as these small forest fragments were not capable of supporting self-sustaining populations, but the Red-shouldered Hawk has recently reappeared as a result of more forest cover than was present in the late 1960s and early 1970s (Campbell 1975; Sharp and Campbell 1982; Bryant 1986).

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Woodland raptors may potentially be affected by rock quarries and mines and are much less likely to be affected by sand and gravel pits as potential sites for these uses tend to be open in nature.

Quarries and mines can result in direct habitat loss for woodland raptors if forests are cleared for aggregate or mineral extraction. In many cases, however, these resources may also be of provincial significance.

Indirect effects may occur if portions of the forest are destroyed or disturbed, or if the habitat within the woodland becomes wetter or drier as a result of dewatering activities, pumping, or reduction in the size of the surface watershed of the woodland. Changes in hydrology or the water table may affect woodland pools and their viability to support amphibian populations that may be important prey for some raptor species.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes a 50 – 400 m radius of habitat around the active nest, depending on the species (see Criteria Tables for further details).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, excavation and/or filling for development in woodland raptor nesting SWH will destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible and site it at the edge of the habitat to reduce effects from habitat fragmentation. Avoid disturbing the most critical habitat areas for nesting raptors including the nest site, the territory around the nest, and key foraging areas along with habitat for the primary prey species.

OMNR (2008a) recommended that new pits and quarries not be permitted within 50 m of active or alternate nest sites of Northern Goshawk, Red-shouldered Hawk, or Great Gray Owl, or within the 7 ha of suitable habitat retained within 200 m of primary nests. New aggregate operations are not permitted within 50-200 m of active nests of other species in this guild (excluding the previously mentioned three). Setbacks of 50 m are recommended for Sharp-shinned Hawk and Merlin and 200 m for Barred Owl, while 100 m is recommended for the other species.

If only a portion of the woodland is necessary for removal, this would preferably be along existing edges of the woodland to minimize fragmentation and edge effects.

Hydrological and possibly hydro-geological surveys should be undertaken to see if extraction operations will affect the amount of surface water in the woodland, or if the depth to the water table will be affected. It may be possible to maintain the existing water table and hydro-period by pumping or establishing impermeable barriers around the extraction activities. Any water that is directed toward the woodland from the operation of the facility should first run into a settling pond or stormwater management pond to ensure that contaminants and excess nutrients are not delivered to woodland pools.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Despite the environmental benefits associated with wind energy, considerable controversy has accompanied the development of wind power facilities and their effects on birds. The main adverse effects of wind power facilities on raptors are mortality through collision with turbine blades and other structures, and displacement of foraging birds as a result of disturbance at the project site (Fielding et al. 2006; Madders and Whitfield 2006). Displacement effectively results in the loss of foraging and breeding habitat (Fielding et al. 2006).

Few long-term studies have been conducted on the impacts of wind power facilities on birds, and the focus has been on collision rather than disturbance (Kingsley and Whittam 2005). In terms of disturbance effects, early evidence suggests that habitat loss through displacement may be occurring. In a Norwegian study, the number of White-tailed Eagle pairs holding territories within 500 m of a wind farm site fell from 13 pre-construction to only 5 at 4 years post-construction (Nygard et al. 2010), suggesting displacement of the missing pairs. Additionally, at the wind power site in Wisconsin, raptor abundance was reduced 47% post-construction compared to pre-construction levels (Garvin et al. 2010). The authors concluded that this decline may have been a result of displacement due to the disturbance of wind farm construction and the ongoing presence of turbines and maintenance machinery. Another study in Wisconsin (Howe et al. 2002, in Garvin et al. 2010) found that open-country raptors were more abundant in the reference area surrounding the subject wind farm than within the wind farm study area. Displacement has not been studied at the Californian Wind Resource Areas (Whitfield 2009). On the other hand, there was no evidence of Golden Eagle displacement at Foote Creek Rim, Wyoming (Johnson et al. 2000, in Whitfield 2009. Lack of displacement means little indirect habitat loss, but it also means that the birds are at risk by venturing into the environs of operating turbines.

Diurnal raptors (e.g., eagles, buteos, accipiters, Northern Harrier, Osprey, falcons, and Turkey Vultures) appear to be particularly susceptible to being killed by striking turbine blades at wind power facilities. Bird vulnerability and mortality reflects a combination of site-specific (wind-relief interaction), species-specific and seasonal factors (Barrios and Rodríguez 2004). Raptors are more likely to collide with turbine blades than many other avian species due to their morphology and foraging behaviour (e.g., heavy wing loading, focus on distant prey (Janss 2000; Kikuchi 2008)). High mortality rates have been documented in California and at Tarifa and Navarre in Spain (Kingsley and Whittam 2005). At Altamount Pass and Tehachapi Pass in California, most raptor deaths were recorded during the winter when the birds were hunting for mammalian prey (Kingsley and Whittam 2005). Drewitt and Langston (2008) stated that certain birds of prey have good binocular vision but poor peripheral vision, which might explain why they run into transmission wires and turbine blades. Additionally, some raptor species may begin courtship displays in late winter in anticipation of the breeding season. Those that display aerially, such as Northern Harrier and Short-eared Owl, may be particularly vulnerable to being struck by turbine blades. At a Wisconsin wind power project, Turkey Vultures and Red-tailed Hawks displayed high-risk flight behaviours more often than all other raptor species at the site (Garvin et al. 2010). Negative impacts on raptors using a wintering area will, in turn, have a negative impact on the habitat itself by reducing its ecological function as a wintering area.

The most important factor that influences turbine-related mortality for raptors appears to be topography. Landform features such as elevation, ridges and slopes are likely very important in determining the amount of raptor mortality in areas where raptors are abundant (Anderson et al. 2000, in Kingsley and Whittam 2005). Higher elevations and complex terrain (many ridges and slopes) appear to coincide with greater raptor mortality than lower elevations and simpler terrain.

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Site preparation that includes the clearing of nest trees results in the direct loss of habitat for breeding hawks and owls.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the outer edge of any woodland raptor nesting SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. The SWH includes a 50 – 400 m radius of habitat around the active nest, depending on the species (see Criteria Tables for further details). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in woodland raptor SWH will destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible and site it at the edge of the habitat. New wind installations must be preceded by detailed behavioural observation of soaring birds as well as careful mapping of migration routes (Barrios and Rodríguez 2004).

Another possible mitigation option might be to make the habitat immediately around each turbine unattractive to raptors and their prey species. If the area is essentially devoid of perches and prey, raptors may be encouraged to hunt elsewhere. For example, installing larger than standard turbine pads and/or keeping the surrounding vegetation very short may be effective strategies. Additionally, there is speculation in the literature that the construction of tubular (as opposed to lattice-type) towers and slower blade speeds may also help to reduce raptor fatalities at wind power facilities. There is some evidence that lattice-type towers encourage raptor perching which puts the birds at risk from collision mortality (Smallwood and Thelander 2004). If lattice-type towers must be used, wrapping the tower with wire mesh may be sufficient to discourage perching by raptors.

Potential Development Effects: Solar Power Facilities

Development can have significant impacts on the breeding habitat of woodland raptors. Site alterations which reduce the availability of forest cover effectively remove productive habitat from the territory of resident breeding pairs. Depending on the size of the area affected and the overall availability of woodland habitat, there may be a significant reduction in the amount of food available to feed offspring. This in turn affects brood rearing success, impacting population growth and the long-term persistence of woodland raptors. Forest fragmentation or decreasing forest size can have adverse effects on species such as Northern Goshawk, Red-shouldered Hawk, and Barred Owl. All of the raptors in this guild have large home ranges and require large areas in which to hunt. Prey populations fluctuate annually, and any loss of habitat for the raptors or their prey may result in a decline of woodland raptors or their local extirpation from a forest.

The clearing of wooded landscapes tends to promote regeneration, which makes hunting much more difficult for species such as Northern Goshawk, Red-shouldered Hawk and Barred Owl. Forest clearing also creates edge habitat, benefitting competitive edge species such as the Red-tailed Hawk, which may ultimately displace the Red-shouldered Hawk in the area.

Development may affect wetland habitat or woodland pools by discharge of stormwater or drying due to reduced infiltration. This can reduce prey availability for species that consume many amphibians, such as the Red-shouldered Hawk. Most raptors require more than one habitat type within their home range to satisfy their nesting and foraging needs.

Human disturbance, particularly if it occurs frequently, may lead to nest abandonment. Once displaced, a breeding pair will have to seek other suitable nest sites within their territory. If none exist, they will have to compete with other birds for access to suitable nesting sites elsewhere. Only birds successful at defending nesting sites will breed. The end result is a reduction in nesting habitat within the area and ultimately a reduction in raptor numbers. Because the nests of most species are spaced considerable distances apart, the loss of one nesting territory probably means that one less pair will breed.

Development on adjacent lands may have considerable impact on breeding habitat if it results in an increase in human activity within the pair's territory. Intrusions into the traditional nesting habitat during the nesting season may result in birds abandoning the site. Increased human activity and site alterations which affect food availability, or which simply prevent raptors from foraging in the area, may result in a reduction of accessible food within the territory to the point that brood survival is impacted. Birds cannot switch to new feeding sites since chances are they occur within the territories of other breeding pairs, or there may be no suitable habitat nearby.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of the outer edge of any woodland raptor nesting SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The SWH includes a 50 – 400 m radius of habitat around the active nest, depending on the species (see Criteria Tables for further details). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing for development in woodland raptor nesting SWH will destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible and site it at the edge of the habitat to reduce effects from habitat fragmentation. Avoid disturbing the most critical habitat areas for nesting raptors including the nest site, the territory around the nest, and key foraging areas along with habitat for the primary prey species.

Many woodland species do not adapt well to reductions in the size of forests and fragmentation of existing woodlands. Forest size and integrity need to be protected as much as possible when planning for development. Forest sizes should never be reduced below the minimum forest size requirements of the most sensitive species present. Although it may be possible to create additional forested lands through planting or allowing areas to grow back naturally, this is a slow process and is not suitable compensation for the loss of forest habitat. Many species may be reduced to critically low numbers, or extirpated, in the intervening time period, and new habitat may not be colonized in the future.

Mitigating the effects of development on woodland raptor breeding habitat involves preventing the loss of forest cover, maintaining the existing forest structure, and ensuring that increased human activity does not occur near nests during the nesting season.

Clearing and construction should always be directed as far away from existing nests as possible. Given the importance of nest sites and the way raptors use perches located in surrounding habitat, a buffer from active nests where no development is allowed may be required to prevent the loss of nesting habitat function. This is particularly important for species that tend to build new nests a distance from the previous year's nest.

James (1984a) suggested times when activity should be restricted in woodland raptor nesting areas. These restrictions were March through June for Northern Goshawk, March through July for Cooper's Hawk, April through July for Sharp-shinned Hawk, and March through July for Red-shouldered Hawk.

OMNR (2008a) provided updated forest management recommendations for woodland raptor nests. For the Northern Goshawk and Red-shouldered Hawk, a total of 28 ha of unharvested or lightly harvested mature forest should be retained as suitable nesting habitat within a radius of 400 m, and 7 ha of this suitable nesting habitat will be within 200 m of the nest. These same amounts of forested habitat need to be retained as a minimum when establishing solar power development, provided that there is that much forest present initially.

Appropriate stormwater management will be required to ensure that woodland pools and wetlands and the amphibians they support are not adversely affected. It should be demonstrated that development will not have negative impacts on water quality or quantity which could ultimately affect raptor prey populations.

Many raptors are generally not very adaptable to new habitat conditions. Nonetheless, most raptor species appear to be expanding their range in Ontario based on results of the second Ontario Breeding Bird Atlas (Cadman et al. 2007). Raptors are particularly vulnerable to changes in habitat because they tend to return to the same area to nest year after year. They may do this even if the habitat has become unsuitable to the point where nesting birds do not raise a brood. In Waterloo Region, Red-shouldered Hawks continued to return to traditional nesting sites even after the forests in which they nested were reduced to areas as small as 4 ha. Eventually, the Red-shouldered Hawk was temporarily extirpated from the Region of Waterloo as these small woodland fragments were not capable of supporting self-sustaining populations, but the Red-shouldered Hawk has recently reappeared as a result of more forest cover than was present in the late 1960s and early 1970s (Campbell 1975; Sharp and Campbell 1982; Bryant 1986).

ROAD DEVELOPMENT

Potential Development Effects

Roads may affect habitat for woodland raptors through direct habitat loss or forest fragmentation. Roads may also act as barriers to the movement of surface water and groundwater and this has the potential to affect adjacent habitat that may be significant to raptors. Sediments and other contaminants may be introduced into adjacent habitat by runoff from roads.

Site alterations which reduce the availability of forest cover effectively remove productive habitat from the territory of resident breeding pairs. Depending on the size of the area affected and the overall availability of woodland habitat, there may be a significant reduction in the amount of food available to feed offspring. This in turn affects brood rearing success, impacting population growth and the long-term persistence of woodland raptors. Forest fragmentation or decreasing forest size can have adverse effects on species such as Northern Goshawk, Red-shouldered Hawk, and Barred Owl. All of the raptors in this guild have large home ranges and require large areas in which to hunt. Prey populations fluctuate annually, and any loss of habitat for the raptors or their prey may result in a decline of woodland raptors or their local extirpation from a forest.

Roads may affect wetland habitat or woodland pools by discharge of stormwater or drying due to reduced infiltration. This can reduce prey availability for species that consume many amphibians, such as the Red-shouldered Hawk. Most raptors require more than one habitat type within their home range to satisfy their nesting and foraging needs. Roads may act as dams to surface and ground water flow, resulting in more water on one side of the road and less on the other. This has the potential to change habitat for woodland raptors and their prey. Treed swamps, which may provide good raptor habitat, may be converted to cattail marsh on the wetter side of the road, making the habitat generally unsuitable. Woodland pools may be dried up on the drier side of the road.

Construction activity in the vicinity of nesting habitat may cause birds to abandon the area. Frequent disturbance can lead to nest abandonment. Once displaced, a breeding pair will have to seek other suitable nest sites within their territory. If none exist, they will have to compete with other birds for access to suitable nesting sites. Only birds successful at defending nesting sites will breed.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes a 50 – 400 m radius of habitat around the active nest, depending on the species (see Criteria Tables for further details).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, excavation and/or filling for development in woodland raptor nesting SWH will destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible and site it along the edge of the habitat to reduce effects from habitat fragmentation. Avoid disturbing the most critical habitat areas for nesting raptors including the nest site, the territory around the nest, and key foraging areas along with habitat for the primary prey species.

James (1984a) suggested times when activity should be restricted in woodland raptor nesting areas. These restrictions were March through June for Northern Goshawk, March through July for Cooper's Hawk, April through July for Sharp-shinned Hawk, and March through July for Red-shouldered Hawk.

OMNR (2008a) recommended that new roads not be constructed within 20 m of nests of species in this guild. These recommendations, however, were for forest management roads constructed outside of the breeding season. Roads that support higher traffic may require larger setbacks. The impacts of roads on raptors is equivocal, as most studies fail to show an avoidance of roads by the raptors within this guild, and some appear to nest closer to low-traffic roads and trails than would be expected by chance.

Sufficient culverts should be installed to ensure free movement of surface water and groundwater under the road. If there are woodland pools present that are important for prey of woodland raptors, it may be necessary to install stormwater management ponds to ensure that excessive amounts of sediments and nutrients do not reach these pools.

INDEX #28: REPTILE NESTING AND OVERWINTERING AREAS

Ecoregions:	3E, 5E, 6E, 7E
Species Group:	Turtles: Midland Painted Turtle, Snapping Turtle (SPECIAL CONCERN), Northern Map Turtle (SPECIAL CONCERN), Eastern Musk Turtle (SPECIAL CONCERN)
Lizards: Five-lined Skink, Canadian Shield population (SPECIAL CONCERN)	
Significant Wildlife Habitat Category:	Rare or Specialized Habitat
Functional Habitat:	Nesting and Overwintering Areas The Five-lined Skink, Carolinian population, Spotted Turtle and Wood Turtle are (ENDANGERED), the Blandings Turtle, Spotted Turtle and Eastern Spiny Softshell are (THREATHENED) under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that may affect these species.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

This index contains information about nesting and overwintering habitats for turtles, and nesting habitat for Ontario's only lizard species, the Five-lined Skink. Information about skink wintering habitat is provided in Index #13.

Turtles – Nesting and Overwintering

Many of Ontario's turtles build nests along shoreline beaches. They use these areas because they are located near water and are able to dig out nests in the light sand and gravel. These areas also afford good exposure to sun and allow faster development of eggs (Carr 1952; Froom 1971, 1976; Cook 1984; Gilhen 1984; Lamond 1994).

Sand and gravel beaches located near good turtle habitat (undisturbed shallow weedy areas of marshes, lakes, and rivers) are most frequently used. Some beach strips are used by many turtles from the surrounding area each year (Carr 1952; Froom 1971, 1976; Cook 1984; Gilhen 1984; Lamond 1994). In areas where sand or gravel beach is in limited supply, isolated beaches become highly significant for the maintenance of viable turtle populations. Certain turtles may also nest at stream crossings and interfaces between creeks and marshes.

The exposed sand and gravel on beaches (or roadsides, railways, etc.) absorb heat from sunlight warming the substrate. This heat helps incubate the eggs, allowing them to hatch more quickly, leading to higher survival rates of young turtles.

For an area to function as a turtle nesting area, it must provide sand and gravel that turtles are able to dig in along with appropriate exposure to sun in areas that are free of vegetation and have good drainage. The beach must be wide and elevated enough that high water does not inundate nests. Predators like striped skunks, raccoons and others will dig out and eat eggs. Large wide beaches provide more nesting area and consequently reduce the odds that nests will be found by predators. Beaches adjacent to permanent water are preferred. When turtles must cross roads to nest or reach water, there is often high mortality.

Turtles typically hibernate underwater during winter. Species that are tolerant of low oxygen conditions (anoxia-tolerant) often hibernate buried in mud or organic substrates; those that are not tolerant of low oxygen conditions (anoxia-intolerant) may be only partially buried or may be totally exposed during hibernation (Ultsch 2006). Hibernacula are typically located in water that is sufficiently deep to avoid freezing. Most species exhibit communal use and site fidelity to hibernacula.

Many species of turtles, including the Northern Map Turtle, hibernate communally. Hibernation sites are critical habitat and disturbance of turtles during winter may result in mortality. Loss of hibernacula may be a significant limiting factor to local populations. Female map turtles clump together when they move into the hibernaculum in late autumn. The females remain together and are very sluggish, but the males move frequently around the females and may occasionally be seen moving under the ice (Trute 2004).

Lizards – Nesting

Skinks occur in two rather different habitat settings in Ontario. Skinks occur among the sandy beaches and dunes of Lake Erie and Lake Huron shorelines and adjacent woods as well as in barren rock/woodland settings of the southern Canadian Shield (Oldham and Weller 2000).

In shoreline habitat, skinks prefer undisturbed areas of beaches and dunes which have some vegetation cover. Downed woody debris and other structures which provide hiding cover are very significant habitat elements (Seburn and Seburn 1998; Environment Canada 2007b). This structure allows skinks to avoid predation from the many gulls which frequent these shoreline areas. Skinks spend considerable time basking in sunlight (Seburn and Seburn 1998). Females prefer to nest in large, moderately decayed logs and multiple and communal nesting often occurs in these logs even when nest sites are not limited. Nesting also occurs under boards (Hecnar 1994). Nests were at sites where soil moisture was significantly higher than in adjacent areas, and females moved their clutches in response to dry periods and precipitation to keep them at the appropriate moisture level (Hecnar 1994).

Seburn (1993) found that skinks were aggregated with males aggregated throughout the breeding season; females and yearlings both aggregated during the period when females were gravid; and the population as a whole was aggregated during all time periods. Almost all skinks found in this study were on the stabilized dunes. The colonial nature of this species resulted in certain areas being occupied virtually all of the time while other apparently suitable habitat was unused.

For a shoreline area to function as skink habitat it must provide undisturbed vegetated areas. A key feature of skink habitat is an abundance of ground-level structure. Downed woody debris, rocks, and other structures that skinks can hide in or under contribute much to reproduction and survival (Seburn and Seburn 1998; Environment Canada 2007b). Boards and construction debris may also be used for hiding and nesting (Environment Canada 2007b).

On the Shield, skinks prefer moist woods with forest openings. Many of these openings are rocky outcrops which are used for basking. Downed woody debris and light sandy soil are very significant habitat elements. Skinks are found frequently under logs, deep leaf litter, rocks, sawdust piles, etc. Eggs are laid in rotting logs or light soil, often under logs or rocks. Females sometimes guard eggs, and there may be multiple clutches laid by several females. Skinks hibernate in rotting logs or underground below the frost line. They also spend considerable time basking in the sun on rocks, or on rock outcroppings in open areas (Seburn and Seburn 1998; Environment Canada 2007b).

For a woodland area to function as skink habitat, it must have a moist understory. Skinks are generally found close to permanent water. These conditions are usually provided by mature deciduous or mixedwood stands. Forest openings are important elements. Openings may be provided by gaps in the forest canopy due to tree fall or cutting, or by areas of rock outcroppings. Large downed woody debris in a moderate state of decay is preferred nesting habitat while rocks and other structures that skinks can hide in or under provide suitable cover and basking sites (Seburn and Seburn 1998; Hecnar 1994; Environment Canada 2007b). On shorelines, the Five-lined Skink is usually found under debris washed up on shore or under wood on sandy dunes (Environment Canada 2007b).

Skinks may be locally abundant throughout their range, but they tend to be discontinuous in distribution (Oldham and Weller 2000; Environment Canada 2007b).

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Turtles – Nesting and Overwintering

Potential Development Effects

Shoreline development which includes site alterations to sand and gravel beaches has the greatest potential to affect turtle nesting sites. Development can reduce the amount of available habitat to the point where nests become very vulnerable to predation. Nests become easy to find because they are concentrated in a small area.

Construction of retaining walls and other structures which prevent access to the beach from water will eliminate the function of a beach as a turtle nesting site. Grading and filling can remove valuable nesting substrate. Excavation and dredging which alter shoreline hydrology may result in the destruction of the function of the beach as a turtle-nesting area.

Increased human activity associated with development affects turtle nesting sites in two fundamental ways. Human activity on the beach during spring and early summer will discourage turtles from using the site. Raccoons and Ring-billed Gulls often concentrate around areas of human activity foraging on refuse. These two species are serious predators of eggs and newly-hatched turtles.

Moore and Seigel (2006) studied the impacts of human disturbance on the Yellow-blotched Map Turtle, which is closely related to the Northern Map Turtle. Turtles attempting to nest commonly abandoned their attempts upon the approach of a boat. Their data suggested that interruption of nesting activities could have an especially severe impact on the viability of this particular population. In contrast, Bowen and Janzen (2008) studied the impact of human recreation on the nesting ecology of the Painted Turtle and found that intensity of human recreation on and near the nesting beach did not affect the decision of turtles to emerge from the water and nest. They concluded that their results were contrary to those of most studies and recommended that species-specific and population-specific studies be undertaken to assess impacts of human activities on nesting turtles.

Development on adjacent land is not expected to affect the function of beaches as nesting habitat provided it does not result in the release of contaminants into soil or water, increase human activity in the nesting area (including the collection of turtles for pets), or result in barriers to turtle movement patterns.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Mitigating the effects of development on turtle-nesting habitat involves ensuring that not all beach areas are developed or otherwise used by humans. Ideally, all beaches used for nesting by turtles would be left intact. If some development on the beach is necessary, the width of the beach should never be decreased, and spaces at least 30 m long need to be left between individual houses or cottages. It may be necessary to post the area as being off limits during critical periods (April 1 – Sept. 30) or even fence it to reduce human usage. Any fencing should be designed so that it allows free passage of turtles. Adequate connectivity between shorelines and nesting/overwintering habitat must also be maintained (Painted Turtles may travel significant distances from the water to find appropriate nesting habitat).

On lakes or rivers where there is a limited supply of sand or gravel beach these provisions take on higher significance. Areas with known use should always be protected. Reducing the size of suitable nesting areas may lead to a loss of function due to high nest predation.

In areas where the beach will be developed, planning needs to ensure that breakwalls or other structures do not isolate the beach from the water. Even a modest wall (i.e., < 20 cm high) may prevent turtles from accessing the beach and having negative effects on the habitat.

Neighbourhood roads should always be designed so that they are not barriers to turtles travelling between water and nesting areas. If this is not possible, suitable underpasses need to be provided. Woltz et al. (2008) found that Painted Turtles preferred tunnels that were 0.5-0.6 m in diameter. Fences 0.6 m in height were effective barriers to Snapping Turtles while 0.3 m high fences excluded Painted Turtles. It should be noted, that Woltz et al. (2008) placed the turtles within an enclosure and the tunnels were the only way out, so their experiment did not determine if turtles would willingly enter these tunnels.

In Florida, Aresco (2014) found that road undercrossings were very effective in reducing turtle mortality. A 60-cm high barrier was erected that directed turtles away from the road into a metal culvert 3.5 m in diameter and 46.6 m long. There was a natural substrate of sand and silt in the culvert. Although many turtles passed through the underpass, the author physically moved a large proportion of them across the highway. He concluded that barrier fences in conjunction with large culverts were effective in providing turtle underpasses. He recommended a more permanent barrier including design features as a 1-m tall smooth vertical surface with an over-hanging, inward facing lip to prevent turtles from climbing over it. In addition, a series of large culverts needs to be provided.

Interpretative signage may also decrease the incidence of road mortality. This, however, has not been particularly effective at Long Point, and some motorists deliberately run over turtles (Ashley et al. 2007).

It may be possible to produce new or alternate nesting areas. This is, of course, a risky proposition since there is no guarantee that the newly-created site will be used by turtles. Proponents need to demonstrate that this strategy works before development proceeds.

Five-lined Skink – Nesting

Potential Development Effects

Development which affects shoreline areas or moist woodlands has the potential to impact significant portions of preferred skink habitat owing to their high dependence on these habitats. Since the distribution of skink populations tends to be patchy, development in areas where skinks are abundant can potentially affect an entire local population.

Tree-cutting and lot-clearing activities reduce the quantity of remaining shoreline or woodland habitat for skinks. The loss of downed woody debris and other structural elements of beach, dune, or forest floor habitat greatly reduces the utility of the area for skinks.

Development on adjacent land is not expected to directly affect skink populations in their preferred habitat, unless it affects moisture regimes in preferred habitat.

Increased human usage can have negative impacts on skink habitat. Degradation of vegetation and loss of ground structure may occur, and structural loss may reduce habitat suitability and food supply for skinks. Urban species such as skunks, raccoons, and pets may result in increased predation. Humans may also collect skinks as pets, and they are still collected for the pet trade (Environment Canada 2007b).

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Mitigating the effect of development on Five-Lined Skink habitat in shoreline habitat involves protection of adequate areas of beach from development and human activity. Areas of natural vegetation and accumulated driftwood and fallen dead timber, etc. should be protected or enhanced.

Any development that has the potential to affect skink populations should attempt to determine if the population is isolated or part of a larger population. For isolated populations, enough area of suitable habitat must be maintained to support a viable population. When the area that may be affected is part of a larger population, the development must not result in the isolation of the population, allowing access to and from the area by skinks.

The activity area of skinks should be determined. A large proportion of a population may concentrate in a relatively small area. Females may, however, shift their activity out of this home range during the nesting period (Seburn 1993). Therefore, to properly predict the impacts of development on skinks, it is necessary to be aware of their concentration areas, nesting areas, and sites that may be used during other periods of their life cycle.

In woodland habitat, the amount of tree cutting in preferred habitat should be restricted. Skink populations may benefit by increasing the amount of downed woody debris and other forms of ground-level structure.

On lands adjacent to forested skink habitat, appropriate stormwater management or infiltration may be required to ensure that the forest floor does not become drier and that woodland pools do not dry up.

MAJOR RECREATIONAL DEVELOPMENT

Turtles – Nesting and Overwintering

Potential Development Effects

Marinas and beach developments are the types of major recreational development most likely to affect turtle nesting and wintering areas. Golf courses also have the potential to affect nesting sites if they are near the shorelines of watercourse or water bodies. Creation of sand traps may entice turtles to nest in these areas, but egg survival is likely to be low due to disturbance.

Shoreline development which includes site alterations to sand and gravel beaches has the greatest potential to affect turtle nesting sites. Development can reduce the amount of available habitat to the point where nests become very vulnerable to predation. Nests become easy to find because they are concentrated in a small area.

Construction of retaining walls and other structures which prevent access to the beach from water will eliminate the function of a beach as a turtle nesting site. Grading and filling can remove valuable nesting substrate. Excavation and dredging which alter shoreline hydrology result destroy the function of the beach as a turtle-nesting area.

Increased human activity associated with development affects turtle nesting sites in two fundamental ways. Human activity on the beach during spring and early summer will discourage turtles from using the site. Raccoons and Ring-billed Gulls often concentrate around areas of human activity foraging on refuse. These two species are serious predators of eggs and newly-hatched turtles.

Moore and Seigel (2006) studied the impacts of human disturbance on the Yellow-blotched Map Turtle, which is closely related to the Northern Map Turtle. Turtles attempting to nest commonly abandoned their attempts upon the approach of a boat. Their data suggested that interruption of nesting activities could have an especially severe impact on the viability of this particular population. In contrast, Bowen and Janzen (2008) studied the impact of human recreation on the nesting ecology of the Painted Turtle and found that intensity of human recreation on and near the nesting beach did not affect the decision of turtles to emerge from the water and nest. They concluded that their results were contrary to those of most studies and recommended that species-specific and population-specific studies be undertaken to assess impacts of human activities on nesting turtles.

Development on adjacent land is not expected to affect the function of beaches as nesting habitat provided it does not result in the release of contaminants into soil or water, increase human activity in the nesting area (including the collection of turtles for pets), or result in barriers to turtle movement patterns.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Mitigating the effects of development on turtle-nesting habitat involves ensuring that not all beach areas are developed or otherwise used by humans for recreation. Ideally, all beaches used for nesting by turtles would be left intact. If some development on the beach is necessary, the width of the beach should never be decreased, and spaces at least 30 m long need to be left between individual structures. It may be necessary to post the area as being off limits during critical periods (Apr. 1 – Sept. 30) or even fence it to reduce human usage. Any fencing should be designed so that it allows free passage of turtles, but inhibits access by raccoons and skunks. Adequate connectivity between shorelines and nesting/overwintering habitat must also be maintained (Painted Turtles may travel significant distances from the water to find appropriate nesting habitat).

On lakes or rivers where there is a limited supply of sand or gravel beach these provisions take on higher significance. Areas with known use need to be protected. Reducing the size of suitable nesting areas may lead to a loss of function due to high nest predation.

On golf courses, there may be opportunities to create additional habitat for turtles. Ponds used for aesthetic purposes and for water traps may provide aquatic habitat for turtles and these may be suitable overwintering sites for Painted Turtles. Sandy shorelines could also be provided along artificial ponds to provide potential nesting areas. This should only be considered if the nesting area will not be disturbed by golfers.

In areas where the beach will be developed, planning needs to ensure that breakwalls or other structures do not isolate the beach from the water. Even a modest wall (i.e., < 20 cm high) may prevent turtles from accessing the beach and having negative effects on the habitat.

Five-lined Skink – Nesting

Potential Development Effects

Due to the varied habitats that the Five-lined Skink uses within its Ontario range, it could potentially be affected by golf course development and ski slopes.

Golf courses have the potential to convert habitat for the skink into manicured areas. Depending on the location of critical skink habitats in relation to golf course holes, the manicured fairways could potentially be a barrier to movement among habitats. Cutting of swathes through forested habitat could destroy habitat and result in removal of fallen logs that may function as cover, basking areas, or nest sites. Opening up swathes through forest cover could also make the area drier and less suitable for skinks.

Ski slopes also have the same potential to affect the Five-lined Skink by creating linear openings in forested cover. In some areas, ski runs may be located on the Niagara Escarpment. In these areas, rocks at the base of the slope may be removed, and these are potentially good cover and basking sites.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Mitigating the effect of development on Five-Lined Skink habitat in shoreline habitat involves protection of adequate areas of beach from development and human activity. Areas of natural vegetation and accumulated driftwood and fallen dead timber, etc. should be protected or enhanced. Fairways and ski runs should be situated so that they are not in critical habitat.

It may be possible to provide additional habitat features for the Five-lined Skink at both golf courses and ski resorts. Logs removed from forest clearing operations should be placed in strategic locations where they have the potential to provide future nesting sites. Also, rocks could be placed in areas to enhance conditions for basking and hiding.

AGGREGATE AND MINE DEVELOPMENT

Turtles – Nesting and Overwintering

Potential Development Effects

New sand and gravel pits adjacent to turtle habitat are likely to attract nesting females. These sites are typically poor nesting sites due to extraction and equipment activity. Nests in these areas have low potential for success, so that the annual reproductive effort of the female may be lost.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

While active extraction is occurring, the site should be fenced to exclude turtles.

When the pit is rehabilitated, there may be opportunities to create suitable nesting habitat for turtles. Nesting beaches of sand or gravel could be constructed for use by nesting females. If this is going to be considered, the area needs to be large enough so that nests are not concentrated in a small area where they are likely to be easily found by predators.

Five-lined Skink – Nesting

Potential Development Effects

Habitat for the Five-lined Skink is most likely to be affected by sand and gravel pits south of the Shield and rock quarries on the southern Shield.

If forested habitat will be removed as a result of the development, key areas of habitat may be lost. This may include general foraging habitat and nesting areas, as well as basking sites and important cover. It is also possible that a pit or quarry will pose a barrier to skink movement among key habitat features.

Pits or quarries that are established adjacent to significant skink habitat have the potential to affect that habitat indirectly. This may include drying of adjacent woodlands or creating edge effects that alter the characteristics of the woodland. This might include proliferation of shrubs in the understory of the woodland, thereby making the habitat less suitable for the skink.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Mitigating the effect of development on Five-Lined Skink habitat in shoreline habitat involves protection of adequate areas of beach from development and human activity. Areas of natural vegetation and accumulated driftwood and fallen dead timber, etc. should be protected or enhanced. The extraction areas and associated berms should be situated so that they are not in critical habitat.

It may be possible to provide additional habitat features for the Five-lined Skink at pits and quarries. Logs removed from forest clearing operations should be placed in strategic locations where they have the potential to provide future nesting sites. Also, rocks could be placed in areas to enhance conditions for basking and hiding. The site plans for pits and quarries should identify areas where habitat will be provided for the skink and this should be a commitment that is part of the license requirements under the Aggregate Resources Act.

ENERGY DEVELOPMENT

Turtles – Nesting and Overwintering

Potential Development Effects: Wind Power Facilities

Shoreline development which includes site alterations to sand and gravel beaches has the greatest potential to affect turtle nesting sites. Development can reduce the amount of available habitat to the point where nests become very vulnerable to predation. Nests become easy to find because they are concentrated in a small area.

Construction of retaining walls and other structures which prevent access to the beach from water will eliminate the function of a beach as a turtle nesting site. Grading and filling can remove valuable nesting substrate. Excavation and dredging which alter shoreline hydrology may result in the destruction of the function of the beach as a turtle-nesting area.

Increased human activity associated with development affects turtle nesting sites in two fundamental ways. Human activity on the beach during spring and early summer will discourage turtles from using the site. Raccoons and Ring-billed Gulls often concentrate around areas of human activity foraging on refuse. These two species are serious predators of eggs and newly-hatched turtles.

Moore and Seigel (2006) studied the impacts of human disturbance on the Yellow-blotched Map Turtle, which is closely related to the Northern Map Turtle. Turtles attempting to nest commonly abandoned their attempts upon the approach of a boat. Their data suggested that interruption of nesting activities could have an especially severe impact on the viability of this particular population. In contrast, Bowen and Janzen (2008) studied the impact of human recreation on the nesting ecology of the Painted Turtle and found that intensity of human recreation on and near the nesting beach did not affect the decision of turtles to emerge from the water and nest. They concluded that their results were contrary to those of most studies and recommended that species-specific and population-specific studies be undertaken to assess impacts of human activities on nesting turtles.

Development on adjacent land is not expected to affect the function of beaches as nesting habitat provided it does not result in the release of contaminants into soil or water, increase human activity in the nesting area (including the collection of turtles for pets), or result in barriers to turtle movement patterns.

Nearshore excavation, dredging and drilling activities in turtle overwintering habitat may damage or destroy hibernacula.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the outer edge of any turtle nesting or overwintering SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

The site alterations required to install turbine pads and turbines in turtle nesting or overwintering habitats will damage or destroy the habitat. The best mitigation is to avoid developing in these habitat.

For development on lands adjacent to turtle nesting habitat, implement sediment control and contaminant containment measures during construction. Keep vehicles and workers off the beach at all times, both during construction and afterwards. Ensure that no part of the development interferes with turtle movements to/from the nesting habitat. Schedule regular maintenance to occur outside of the nesting period.

For development in waters adjacent to turtle overwintering areas, implement sediment and contaminant control measures during construction. Schedule construction to occur when turtles are not using the habitat. Keep machinery off the habitat.

Potential Development Effects: Solar Power Facilities

Shoreline development which includes site alterations to sand and gravel beaches has the greatest potential to affect turtle nesting sites. Development can reduce the amount of available habitat to the point where nests become very vulnerable to predation. Nests become easy to find because they are concentrated in a small area.

Construction of retaining walls and other structures which prevent access to the beach from water will eliminate the function of a beach as a turtle nesting site. Grading and filling can remove valuable nesting substrate. Excavation and dredging which alter shoreline hydrology may result in the destruction of the function of the beach as a turtle-nesting area.

Increased human activity associated with development affects turtle nesting sites in two fundamental ways. Human activity on the beach during spring and early summer will discourage turtles from using the site. Raccoons and Ring-billed Gulls often concentrate around areas of human activity foraging on refuse. These two species are serious predators of eggs and newly-hatched turtles.

Moore and Seigel (2006) studied the impacts of human disturbance on the Yellow-blotched Map Turtle, which is closely related to the Northern Map Turtle. Their data suggested that interruption of nesting activities could have an especially severe impact on the viability of this particular population. In contrast, Bowen and Janzen (2008) studied the impact of human recreation on the nesting ecology of the Painted Turtle and found that intensity of human recreation on and near the nesting beach did not affect the decision of turtles to emerge from the water and nest. They concluded that their results were contrary to those of most studies and recommended that species-specific and population-specific studies be undertaken to assess impacts of human activities on nesting turtles.

Development on adjacent land is not expected to affect the function of beaches as nesting habitat provided it does not result in the release of contaminants into soil or water, increase human activity in the nesting area (including the collection of turtles for pets), or result in barriers to turtle movement patterns.

Turtle overwintering areas (underwater hibernacula) are unlikely to be affected by solar power development, unless runoff from the project results in sedimentation or contamination of the habitat.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of the outer edge of turtle nesting or overwintering SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

The site alterations required to install solar panels in turtle nesting habitat will damage or destroy the habitat. The best mitigation is to avoid developing in these habitat.

Mitigating the effects of development on turtle nesting habitat involves ensuring that not all beach areas are developed or accessed by humans. Ideally, all beaches used for nesting by turtles would be left intact. If some development on the beach is necessary, the width of the beach should never be decreased, and spaces at least 30 m long need to be left between structures.

Schedule construction and regular maintenance to occur outside of critical periods (April 1 – Sept. 30). Consider fencing the development to discourage human ingress to the beach. Any fencing should be designed so that it allows free passage of turtles. Adequate connectivity between shorelines and nesting/overwintering habitat must also be maintained (Painted Turtles may travel significant distances from the water to find appropriate nesting habitat).

On lakes or rivers where there is a limited supply of sand or gravel beach these provisions take on higher significance. Areas with known use should always be protected. Reducing the size of suitable nesting areas may lead to a loss of function due to high nest predation.

In areas where the beach will be developed, planning needs to ensure that breakwalls or other structures do not isolate the beach from the water. Even a modest wall (i.e., < 20 cm high) may prevent turtles from accessing the beach and having negative effects on the habitat.

Access roads should always be designed so that they are not barriers to turtles travelling between water and nesting areas. If this is not possible, and the roads are used on a regular basis, suitable underpasses need to be provided. Woltz et al. (2008) found that Painted Turtles preferred tunnels that were 0.5-0.6 m in diameter. Fences 0.6 m in height were effective barriers to Snapping Turtles while 0.3 m high fences excluded Painted Turtles. It should be noted, that Woltz et al. (2008) placed the turtles within an enclosure and the tunnels were the only way out, so their experiment did not determine if turtles would willingly enter these tunnels.

In Florida, Aresco (2014) found that road undercrossings were very effective in reducing turtle mortality. A 60-cm high barrier was erected that directed turtles away from the road into a metal culvert 3.5 m in diameter and 46.6 m long. There was a natural substrate of sand and silt in the culvert. Although many turtles passed through the underpass, the author physically moved a large proportion of them across the highway. He concluded that barrier fences in conjunction with large culverts were effective in providing turtle underpasses. He recommended a more permanent barrier including design features as a 1-m tall smooth vertical surface with an over-hanging, inward facing lip to prevent turtles from climbing over it. In addition, a series of large culverts needs to be provided.

It may be possible to produce new or alternate nesting areas. This is, of course, a risky proposition since there is no guarantee that the newly-created site will be used by turtles. Proponents need to demonstrate that this strategy works before development proceeds.

For development on lands adjacent to turtle nesting habitat, implement sediment control and contaminant containment measures during construction. Keep vehicles and workers off the beach at all times, both during construction and afterwards. Ensure that no part of the development interferes with turtle movements to/from the nesting habitat. Schedule construction and regular maintenance to occur outside of the nesting period.

Five-lined Skink – Nesting

Potential Development Effects: Biofuel Farms

The ploughing and subsequent conversion of fallow lands, meadows, and shrublands to farmland to grow crops for ethanol production (e.g., biomass feedstock such as corn and soy) may destroy critical habitat for the Five-lined Skink. This is most likely to affect the southern population of this species.

It is unlikely that areas where biofuel farms are proposed will support significant habitat for the Five-lined Skink. If they do, however, these areas should not be developed. The site alterations that accompany the cultivation of biofuel crops in skink nesting habitat will physically destroy the habitat.

Cultivated fields also have the potential to block skink movement to/from the habitat, thereby reducing its ecological function as nesting habitat.

Mitigation Options: Biofuel Farms

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Biofuel development in Five-lined Skink nesting habitat will destroy the habitat. The best mitigation is to avoid developing in the habitat.

Corridors among key habitats for the skink should be protected.

It may be possible to provide additional habitat features for the Five-lined Skink along the edges of biofuel fields. Logs from clearing operations should be placed in strategic locations where they have the potential to provide future nesting sites. Also, rocks could be placed in areas to enhance conditions for basking and hiding.

Potential Development Effects: Wind Power Facilities

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Vegetation clearing for turbine pads, access roads and other project components in Five-lined Skink nesting habitat will damage or destroy the affected habitat. The removal of forested habitat may result in the loss of key areas of habitat, including general foraging habitat and nesting areas, as well as basking sites and important cover.

Development on lands adjacent to skink nesting SWH has the potential to interfere with skink movement to/from the nesting habitat, thereby reducing its ecological function as nesting habitat. Adjacent development may also impact skink nesting habitat if it changes the moisture regime of the habitat.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the outer edge of any skink nesting SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing for turbine pads, access roads and other project components in Five-lined Skink nesting habitat will destroy the affected habitat. The best mitigation is to avoid developing in the habitat.

Mitigating the effect of development on Five-Lined Skink habitat in shoreline habitat involves protection of adequate areas of beach from development and human activity. Areas of natural vegetation and accumulated driftwood and fallen dead timber, etc. should be protected or enhanced.

Any development that has the potential to affect skink populations should attempt to determine if the population is isolated or part of a larger population. For isolated populations, enough area of suitable habitat must be maintained to support a viable population. When the area that may be affected is part of a larger population, the development must not result in the isolation of the population, allowing access to and from the area by skinks.

The activity area of skinks should be determined. A large proportion of a population may concentrate in a relatively small area. Females may, however, shift their activity out of this home range during the nesting period (Seburn 1993). Therefore, to properly predict the impacts of development on skinks, it is necessary to be aware of their concentration areas, nesting areas, and sites that may be used during other periods of their life cycle.

In woodland habitat, the amount of tree cutting in preferred habitat should be restricted. Skink populations may benefit by increasing the amount of downed woody debris and other forms of ground-level structure.

For development on lands adjacent to skink nesting habitat, or in an area that is used by skinks to move to/from the nesting habitat, ensure that movement corridors are left undisturbed. Schedule construction to occur outside the time period when the species is most mobile, from late April until late July. After construction is complete, traffic on access roads is so light that it is unlikely to be a problem. Appropriate stormwater management or infiltration may be required to ensure that the forest floor does not become drier and that woodland pools do not dry up.

It may be possible to provide additional habitat features for the Five-lined Skink. For example, if the development is immediately adjacent to skink nesting habitat, enhance the existing habitat by placing logs from clearing operations in strategic locations where they have the potential to provide future nesting sites. Also, rocks could be placed in areas to enhance conditions for basking and hiding.

Potential Development Effects: Solar Power Facilities

Development which affects shoreline areas or moist woodlands has the potential to impact significant portions of preferred skink habitat owing to their high dependence on these habitats. Since the distribution of skink populations tends to be patchy, development in areas where skinks are abundant can potentially affect an entire local population.

Vegetation clearing for the installation of solar panels and other project components in Five-lined Skink nesting habitat will damage or destroy the affected habitat. The removal of forested habitat may result in the loss of key areas of habitat, including general foraging habitat and nesting areas, as well as basking sites and important cover.

Development on lands adjacent to skink nesting SWH has the potential to interfere with skink movement to/from the nesting habitat, thereby reducing its ecological function as nesting habitat. Clearing and other site alterations can reduce the quantity of remaining shoreline or woodland habitat for skinks. The loss of downed woody debris and other structural elements of beach, dune, or forest floor habitat greatly reduces the utility of the area for skinks. Additionally, adjacent development has the potential to adversely affect skink nesting habitat if it changes the moisture regime of the habitat.

Increased human activity at the development site can have negative impacts on skink habitat. Degradation of vegetation and loss of ground structure may occur, and structural loss may reduce habitat suitability and food supply for skinks.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 12 m of the outer edge of skink nesting SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing for the installation of solar panels, access roads and other project components in Five-lined Skink nesting habitat will destroy the affected habitat. The best mitigation is to avoid developing in the habitat.

For development on lands adjacent to skink nesting habitat, or in an area that is used by skinks to move to/from the nesting habitat, ensure that movement corridors are left undisturbed. Schedule construction to occur outside the time period when the species is most mobile, from late April until late July. After construction is complete, traffic on access roads is so light that it is unlikely to be a problem. Appropriate stormwater management or infiltration may be required to ensure that the forest floor does not become drier and that woodland pools do not dry up.

Mitigating the effect of development on Five-Lined Skink habitat in shoreline habitat involves protection of adequate areas of beach from development and human activity. Areas of natural vegetation and accumulated driftwood and fallen dead timber, etc. should be protected or enhanced.

Any development that has the potential to affect skink populations should attempt to determine if the population is isolated or part of a larger population. For isolated populations, enough area of suitable habitat must be maintained to support a viable population. When the area that may be affected is part of a larger population, the development must not result in the isolation of the population, allowing access to and from the area by skinks.

The activity area of skinks should be determined. A large proportion of a population may concentrate in a relatively small area. Females may, however, shift their activity out of this home range during the nesting period (Seburn 1993). Therefore, to properly predict the impacts of development on skinks, it is necessary to be aware of their concentration areas, nesting areas, and sites that may be used during other periods of their life cycle.

In woodland habitat, the amount of tree cutting in preferred habitat should be restricted. Skink populations may benefit by increasing the amount of downed woody debris and other forms of ground-level structure.

It may be possible to provide additional habitat features for the Five-lined Skink. For example, if the development is immediately adjacent to skink nesting habitat, enhance the existing habitat by placing logs from clearing operations in strategic locations where they have the potential to provide future nesting sites. Also, rocks could be placed in areas to enhance conditions for basking and hiding.

ROAD DEVELOPMENT

Turtles – Nesting and Overwintering

Potential Development Effects

Roads which separate water from backshore areas providing sand and gravel for nesting are hazards for turtles. Slow-moving turtles are often hit as they cross roads to get to nesting areas. Many newly-hatched turtles are killed by vehicles as they try to reach water. Grading of shoulders may dig up nests, and spraying emulsified oil on shoulders will affect egg viability by suffocating eggs and direct chemical effects. This will also harden the substrate, potentially preventing emergence of hatchlings.

Roads may be the most significant source of turtle mortality and poorly designed roads have the potential to cause local populations to be extirpated. Aresco (2014) stated that the "road-effect zone", the maximum distance from a road at which significant ecological effects can be detected, varies among species. Road-effect zones range from less than 200 m for sedentary species to more than 2 km for some turtle and frog species. Thus, the effects from roads may be very far-reaching, particularly for long-lived species with low reproductive potential. At the Long Point causeway, turtle mortality was greatest where there were shallow ponds adjacent to the road and were lowest where the adjacent wetland was dominated by shallow-water emergents (Ashley and Robinson 1996). Female turtles are more susceptible to being killed on roads than males as they tend to be more mobile when nesting (Aresco 2005a), and they may nest on the shoulders of roads. The loss of more females than males from the population may further reduce the viability of the population.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Roads need to be designed so that they are not barriers to turtles travelling between water and nesting or overwintering areas. In the case of turtles, the best mitigation for roads is to avoid building them where there is a likelihood that significant mortality will occur.

If this is not possible, suitable underpasses need to be provided. Woltz et al. (2008) found that Painted Turtles preferred tunnels that were 0.5-0.6 m in diameter. Fences 0.6 m in height were effective barriers to Snapping Turtles while 0.3- m high fences excluded Painted Turtles. It should be noted, that Woltz et al. (2008) placed the turtles within an enclosure and the tunnels were the only way out, so their experiment did not determine if turtles would willingly enter these tunnels.

In Florida, Aresco (2014) found that road undercrossings were very effective in reducing turtle mortality. A 60-cm high barrier was erected that directed turtles away from the road into a metal culvert 3.5 m in diameter and 46.6 m long. There was a natural substrate of sand and silt in the culvert. Although many turtles passed through the underpass, the author physically moved a large proportion of them across the highway. He concluded that barrier fences in conjunction with large culverts were effective in providing turtle underpasses. He recommended a more permanent barrier including design features as a 1-m tall smooth vertical surface with an over-hanging, inward facing lip to prevent turtles from climbing over it. In addition, a series of large culverts needs to be provided.

Interpretative signage may also decrease the incidence of road mortality. This, however, has not been particularly effective at Long Point, and some motorists deliberately run over turtles (Ashley et al. 2007).

Five-lined Skink – Nesting

Potential Development Effects

Excavation and road and building construction may have major impacts on skink populations. Roads may act as barriers to skink movement and may increase mortality rates. Even roads adjacent to preferred habitat may result in barriers and road kill. Development on adjacent lands that affects moisture regimes in woodland habitat may be detrimental to skink populations.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, excavation and/or filling for development in reptile nesting or overwintering SWH will destroy the affected habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, site it along the edge of the habitat to reduce effects from habitat fragmentation, and ensure that it does not alter the quality or quantitiy of water in the habitat.

A study of skink home ranges and movement patterns should be undertaken. Often individuals of this species occur in clusters, with some areas supporting high densities of the species and other apparently suitable habitat being devoid of skinks. Roads should be routed so that they avoid areas of high skink density and so that they do not create barriers between critical habitats within home ranges.

Thought could also be given to providing highway underpasses for the movement of skinks, although the potential effectiveness of this is unknown.

INDEX #29: MINERAL LICKS

Ecoregions:	3E, 5E
Species Group:	Moose, White-tailed Deer
Significant Wildlife Habitat Category:	Rare or Specialized Habitat
Functional Habitat:	Mineral Licks
Habitat Features:	Associated with upwelling groundwater and the soil around these seepage areas

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

In some places groundwater upwelling brings high concentrations of minerals to the surface creating pools or patches of wet soil rich in mineral content. The chemical composition of mineral licks varies greatly from site to site, but common elements include sodium, calcium, and magnesium (Fraser and Reardon 1980; Fraser et al. 1980; 1982). Since not all upwellings contain high mineral concentrations, mineral licks occur infrequently across landscapes.

During spring, herbivores like moose or deer consume plants which are much higher in potassium than sodium. This dietary imbalance results in flushing of sodium from the body. As a result, moose develop a considerable "thirst" for sodium in the spring. Consequently, moose frequently visit mineral licks in the spring to drink sodium-rich water or eat sodium-rich soil. These areas often attract large concentrations of animals; Fraser and Hristienko (1981) estimated that 20 to 28 moose used each of two licks in Sibley Provincial Park and in Quebec, moose were attracted to licks from a radius of 5 km (Couturier and Barrette 1988).

Moose use mineral licks for a period of about 1.5 months beginning with the onset of the growing season. In June, moose use of mineral licks declines as most animals begin using aquatic feeding areas where they consume large quantities of sodium-rich aquatic plants (Thompson and Euler 1988). At two Ontario mineral licks, adult males used the licks most frequently in late May and early June with a pronounced decline in use in mid-June. Adult females used the licks primarily in mid- and late June (Fraser and Hristienko 1981).

For an upwelling or spring seep to function as a mineral lick for moose, it must provide relatively high concentrations of sodium in water or mud. Licks with higher concentrations of sodium attract more visits by moose (Couturier and Barrette 1989). Licks tend to be located in forest openings. The composition and structure of the surrounding forest varies greatly since it is the unique groundwater conditions which determine the location of the lick. Surrounding forest cover and lack of human disturbance are key features of mineral licks. If these conditions are met, then the lick will probably show a long history of seasonal use by moose. This can be recognized by trails radiating from the site, trampled soil and usually exposed rocks (a result of erosion at the site caused by trampling by moose).

Mineral licks rarely occur in areas of granitic bedrock except where the site is overlain by calcareous glacial till. They occur more frequently in areas of sedimentary and volcanic bedrock (another factor leading to their rarity) (Fraser et al. 1980; Thompson and Euler 1988).

Potential Development Effects and Mitigation Options

Development has a high potential for disruption of mineral lick functions. The effects can be manifested in several ways: disruption of hydrological function at the site; disturbance of wildlife use of the lick; and/or complete destruction of the site.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

If development activities within the area identified as significant wildlife habitat (the upwelling and surrounding forest cover) affect the flow of surface water or groundwater, they could easily destroy the mineral lick. Even relatively minor changes in flow rates could alter the chemistry of the lick reducing its quality and hence its usefulness to moose or deer. The risks associated with disruption of surface flow extend into adjacent lands. For instance, development on adjacent lands (e.g., site alterations such as erection of buildings or other structures, grading, filling, or excavation) could reduce infiltration and reduce or eliminate the volume of upwelling. Development also has the potential to alter the water chemistry of upwellings through contamination of surface water or groundwater. Development can also require groundwater usage (i.e. a water well). Pumping of the well for irrigation, drinking, cooling, etc. can disrupt the groundwater flow and impact groundwater discharge and therefore the lick.

Moose are intolerant of human disturbance outside of areas where they are protected, such as provincial parks. Couturier and Barrette (1988) found that moose reacted to human activity at a campground that was 2 km away from a mineral lick. Moose spent shorter periods of time at this lick than at an identical lick 5 km away from human activity. Development within the forest surrounding the upwelling will greatly reduce the use of the mineral lick particularly if human activity is increased during the spring and early summer. Activity or construction of permanent buildings within sight of the upwelling will probably lead to the abandonment of the lick by moose. Development on adjacent land would have to be relatively minor with little increase in daily activity for it to have a benign effect on mineral lick use.

Residential development often brings with it an influx of pets. Dogs in particular may disturb moose and result in abandonment of the mineral lick.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Mineral lick SWH includes the site plus a 120 m radius buffer around the site.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and excavation for development in mineral lick SWH will destroy the affected habitat; human disturbance associated with the development will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

For developments adjacent to mineral lick SWH, leave a visual barrier of natural vegetation between the development and the mineral lick habitat. Alternatively, trees and shrubs could be planted to create a barrier or screen. Leave enough forested habitat around the lick to allow moose and deer to travel to and from the lick. Consider installing fencing along the edge of the development to keep people, pets and ATVs out of the habitat. If fencing is used, it is very important to ensure that it does not block wildlife movement to/from the habitat. Signage and a public education campaign may help people better understand the unique characteristics of the habitat, and the value of leaving it undisturbed. Schedule construction activities to occur when moose are not using the site.

Development on adjacent lands needs to occur in late fall or early spring when moose activity at mineral licks is minimal (Fraser and Hristienko 1981; Couturier and Barrette 1988; Rea et al., 2004) and be carried out during mid-day hours since moose use mineral licks predominantly at night (Fraser and Reardon 1980; Couturier and Barrette 1988; Rea et al. 2004). Such strategies could reduce stress and unneeded energy expenditures for moose that are sensitive to disturbance. Development needs to be planned so that increased human activity in spring and early summer does not occur within sight of the upwelling. Noise associated with the human activities should be minimized at least during the season that moose are using the lick. Dogs should either be kept indoors or be tied up or on a leash when they are outside in the spring. Any new roads should be planned to reduce the potential for moose/vehicle collisions.

There are at least three aspects to consider when managing or regulating disturbance around mineral licks: (1) protection of the mineral lick site; (2) maintaining the integrity and function of the hydrological system feeding the lick (e.g., regardless of whether the development is proposed for the immediate area of the mineral lick, or adjacent lands, great care must be taken to ensure that surface water and groundwater flows and quality are not affected); and (3) minimizing disturbance in surrounding areas during peak visitation times (Rea et al. 2004). Rating the importance of the mineral lick for moose is the first in a series of steps that allows for its consideration in land development planning. How to best protect the site and maintain its integrity depends on several factors including the sensitivity of all species using the lick, the biophysical factors of the site, and the type of development planned for the area.

One method that could be used to identify and classify mineral licks is based on site attributes. A field checklist, such as that developed by Rea et al. (2004), could be used to identify and describe site attributes commonly associated with mineral licks used by moose. Key site attributes for identifying and developing a site identification/classification system for wet mineral licks used by moose include: wet muddy areas or seepage; animal sightings or signs (e.g., pellets, hedged browse, tree rubs, muddy vegetation, bed sites); dense track concentrations; exposed mineral soils with clays or organic materials; trail convergence; trail use (i.e.. wear or compaction); and/or evidence of human activities (e.g., bullet casings, hunting blinds, animal remains, etc.). The degree to which site attributes are evident may vary seasonally.

Because mineral licks are rare features (Thompson and Euler 1988) and have great attraction for moose, development should always avoid these areas. Ontario's 1988 "Timber Management Guidelines for the Provision of Moose Habitat" recommends a minimum buffer of 120 m around mineral licks for moose with the recognition that some development and/or extraction activities (i.e., forest harvesting) may occur under special circumstances within the buffer area. A more conservative development setback, which may be more suitable in southern Ontario where there are often a multitude of pressures on remaining habitat, is 500 m. Unlike other jurisdictions, Ontario recommends a site-specific approach to establishing buffers around a lick site that considers the forest stand and other landscape characteristics (e.g., local hydrology and topography). This includes designing the shape and extent of the buffer zone to ensure the integrity of the site and safe access for moose (OMNR 1988).

Quebec legislation defines a lick narrowly as a swamp, spring, or body of water that contains mineral salts in concentrations greater than 3 parts per million of potassium and greater than 75 parts per million of sodium. Management guidelines dictate that these sites, regardless of site specific attributes, retain a 100 m wide undeveloped reserve zone around the lick (Government of Quebec 2004).

Rea et al. (2004) suggest the following mineral lick management considerations related to the ecological characteristics and role of mineral licks used by moose (which basically summarize the management and mitigative actions listed above):

Ecology	Management
Seasonal use	Avoid seasonal activity peaks
Daily us	Avoid peaks in daily use
Tolerance to disturbance	Gauge habituation to human activity
Trail system	Protect: machine free zones should include habitat/trails
Soils use and biophysical aspects of lick function	Test soils for susceptibility to disturbance, compaction, and erosion
Water sources of lick	Protect: earth moving activity should not disrupt hydrological flow of lick; assess volume/flow of groundwater discharge prior to development and monitor during and after development to detect changes
Vegetation cover	Maintain cover and vegetation requirements proximate to lick

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses and ski resorts are the only types of major recreational development that are likely to affect mineral licks.

If development activities within the area identified as significant wildlife habitat (the upwelling and surrounding forest cover) affect the flow of surface water or groundwater, they could easily destroy the mineral lick. Even relatively minor changes in flow rates could alter the chemistry of the lick reducing its quality and hence its usefulness to moose. The risks associated with disruption of surface flow extend into adjacent lands. For instance, development on adjacent lands (e.g., site alterations such as erection of buildings or other structures, grading, filling, or excavation) could reduce infiltration and reduce or eliminate the volume of upwelling. Development also has the potential to alter the water chemistry of upwellings through contamination of surface water or groundwater. Golf courses use huge amounts of water; often the source is well water. Well pumping can easily alter groundwater flow and hence surface discharge.

Moose are intolerant of human disturbance outside of areas where they are protected, such as provincial parks. Couturier and Barrette (1988) found that moose reacted to human activity at a campground that was 2 km away from a mineral lick. Moose spent shorter periods of time at this lick than at an identical lick 5 km away from human activity. Development within the forest surrounding the upwelling will greatly reduce the use of the mineral lick particularly if human activity is increased during the spring and early summer. Activity or construction of permanent buildings within sight of the upwelling will probably lead to the abandonment of the lick by moose. Development on adjacent land would have to be relatively minor with little increase in daily activity for it to have a benign effect on mineral lick use.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Mineral lick SWH includes the site plus a 120 m radius buffer around the site.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in mineral lick SWH will destroy the affected habitat; human disturbance associated with the development will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

For developments adjacent to mineral lick SWH, leave a visual barrier of natural vegetation between the development and the mineral lick habitat. Alternatively, trees and shrubs could be planted to create a barrier or screen. Leave enough forested habitat around the lick to allow moose and deer to travel to and from the lick. Consider installing fencing along the edge of the development to keep people and machinery out of the habitat. If fencing is used, it is very important to ensure that it does not block wildlife movement to/from the habitat. Signage and a public education campaign may help people better understand the unique characteristics of the habitat, and the value of leaving it undisturbed. Schedule construction activities to occur when moose are not using the site.

Development on adjacent lands needs to occur in late fall or early spring when moose activity at mineral licks is minimal (Fraser and Hristienko 1981; Couturier and Barrette 1988; Rea et al., 2004) and be carried out during mid-day hours since moose use mineral licks predominantly at night (Fraser and Reardon 1980; Couturier and Barrette 1988; Rea et al. 2004). Such strategies could reduce stress and unneeded energy expenditures for moose that are sensitive to disturbance. Development needs to be planned so that increased human activity in spring and early summer does not occur within sight of the upwelling. Noise associated with the human activities should be minimized at least during the season that moose are using the lick. Dogs should either be kept indoors or be tied up or on a leash when they are outside in the spring. Any new roads should be planned to reduce the potential for moose/vehicle collisions.

There are at least three aspects to consider when managing or regulating disturbance around mineral licks: (1) protection of the mineral lick site; (2) maintaining the integrity and function of the hydrological system feeding the lick (e.g., regardless of whether the development is proposed for the immediate area of the mineral lick, or adjacent lands, great care must be taken to ensure that surface water and groundwater flows and quality are not affected); and (3) minimizing disturbance in surrounding areas during peak visitation times (Rea et al. 2004). Rating the importance of the mineral lick for moose is the first in a series of steps that allows for its consideration in land development planning. How to best protect the site and maintain its integrity depends on several factors including the sensitivity of all species using the lick, the biophysical factors of the site, and the type of development planned for the area. Also the source of the mineral lick (headwaters) needs to be identified. This will help determine where development can and cannot occur.

One method that could be used to identify and classify mineral licks is based on site attributes. A field checklist, such as that developed by Rea et al. (2004), could be used to identify and describe site attributes commonly associated with mineral licks used by moose. Key site attributes for identifying and developing a site identification/classification system for wet mineral licks used by moose include: wet muddy areas or seepage; animal sightings or signs (e.g., pellets, hedged browse, tree rubs, muddy vegetation, bed sites); dense track concentrations; exposed mineral soils with clays or organic materials; trail convergence; trail use (i.e.. wear or compaction); and/or evidence of human activities (e.g., bullet casings, hunting blinds, animal remains, etc.). The degree to which site attributes are evident may vary seasonally.

Because mineral licks are rare features (Thompson and Euler 1988) and have great attraction for moose and deer, development should always avoid these areas. Ontario's 1988 "Timber Management Guidelines for the Provision of Moose Habitat" recommends a minimum buffer of 120 m around mineral licks for moose with the recognition that some development and/or extraction activities (i.e., forest harvesting) may occur under special circumstances within the buffer area. A more conservative development setback, which may be more suitable in southern Ontario where there are often a multitude of pressures on remaining habitat, is 500 m. Unlike other jurisdictions, Ontario recommends a site-specific approach to establishing buffers around a lick site that considers the forest stand and other landscape characteristics (e.g., local hydrology and topography). This includes designing the shape and extent of the buffer zone to ensure the integrity of the site and safe access for moose (OMNR 1988).

Quebec legislation defines a lick narrowly as a swamp, spring, or body of water that contains mineral salts in concentrations greater than 3 parts per million of potassium and greater than 75 parts per million of sodium. Management guidelines dictate that these sites, regardless of site specific attributes, retain a 100 m wide undeveloped reserve zone around the lick (Government of Quebec 2004).

Groundwater discharge zones are difficult to mitigate. The best plan is to not develop or disturb the recharge zone and leave the path between the recharge zone and the discharge zone unaltered.

Rea et al. (2004) suggest the following mineral lick management considerations related to the ecological characteristics and role of mineral licks used by moose (which basically summarize the management and mitigative actions listed above):

Ecology	Management
Seasonal use	Avoid seasonal activity peaks
Daily use	Avoid peaks in daily use
Tolerance to disturbance	Gauge habituation to human activity
Trail system	Protect: machine free zones should include habitat/trails
Soils use and biophysical aspects of lick function	Test soils for susceptibility to disturbance, compaction, and erosion
Water sources of lick	Protect: earth moving activity should not disrupt hydrological flow of lick; assess volume/flow of groundwater discharge prior to development and monitor during and after development to detect changes
Vegetation cover	Maintain cover and vegetation requirements proximate to lick

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Stone quarries and mines have the greatest potential to affect mineral licks in this development category. They may result in direct loss of the lick due to extraction or changes in groundwater flow or water quality. Additionally, forest habitat adjacent to licks may be removed, making the general habitat in the vicinity of the lick less attractive to moose.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Mineral lick SWH includes the site plus a 120 m radius buffer around the site.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and excavation for development in mineral lick SWH will destroy the affected habitat; human disturbance associated with the development will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

For developments adjacent to mineral lick SWH, leave a visual barrier of natural vegetation between the development and the mineral lick habitat. Leave enough forested habitat around the lick to allow moose and deer to travel to and from the lick. Consider installing fencing along the edge of the development to keep people and machinery out of the habitat. If fencing is used, it is very important to ensure that it does not block wildlife movement to/from the habitat. Schedule construction activities to occur when moose are not using the site.

Dewatering activities associated with quarries and mines have the potential to draw down the local water table. This has the potential to dry up the mineral lick. Hydro-geological studies will be required to determine if there are likely to be significant effects on mineral licks. The source of water for the lick must be determined. If significant effects are anticipated, existing groundwater regimes might be maintained by pumping or use of artificial recharge wells. This, however, is very difficult to do. There are several quarries in Ontario where this is being proposed, but none have it actually operating in the field yet. It is best to avoid development in the headwaters of the discharge zone.

Water from dewatering activities should never be directed toward the mineral lick if it has the potential to change the chemical composition of the water in the lick. Salt concentrations in the lick may become more diluted and thus less attractive to moose, or contaminants may be introduced into the water seeping from the lick.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Clearing for development in mineral lick habitat will remove critical cover elements of the habitat.

The ecological function of mineral lick habitat may also be affected by development on adjacent lands. Construction, operational noise and maintenance activities may disturb moose and deer using the lick, access roads may block animals from reaching the lick, and the development may change the hydrology of the lick site. Clearing of forested habitat adjacent to or around mineral lick habitat may block moose and deer from reaching the site.

Moose are intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Human activities associated with construction and turbine maintenance will likely disturb moose using the mineral lick habitat if they are within visual range. Moose are also known to respond to noise in the environment, e.g., noise pollution and disturbance are listed as threats in Nova Scotia's recovery plan for mainland moose (NSDNR 2007). However, little seems to be known about moose responses to turbine noise in particular, or to the physical movement of turbines during operation. In a study of behavioural and physiological responses by moose to noise disturbance at a military site in Norway, Anderson et al. (1996) concluded that sources of disturbance identifiable by moose as human elicited flight responses at greater distances and elevated heart rates for longer periods than disturbances that were recognized as mechanical. This study was conducted in the fall; the authors caution that the same level of disturbance in the winter or during calving could have more detrimental effects.

Moose are known to avoid roads (AMEC Americas Limited 2005). Access roads may block moose from reaching mineral lick sites.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 240 m of a mineral lick should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). This distance incorporates the SWH around the lick site plus a 120 m setback of adjacent land. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in mineral lick SWH will destroy the affected habitat. The best mitigation option is to avoid developing in the habitat.

Development on adjacent lands needs to occur in late fall or very early spring when moose activity at mineral licks is minimal (Fraser and Hristienko 1981; Couturier and Barrette 1988; Rea et al., 2004) and be carried out during mid-day hours since moose use mineral licks predominantly at night (Fraser and Reardon 1980; Couturier and Barrette 1988; Rea et al. 2004). Such strategies could reduce stress and unneeded energy expenditures for moose that are sensitive to disturbance. Development needs to be planned so that human activity in spring and early summer does not occur within sight of the upwelling. Natural vegetation needs to be left to conceal buildings, roads, etc. from the lick. Alternatively, trees and shrubs could be planted to create a barrier or screen.

Retain enough forested habitat around the lick to allow moose and deer to travel to and from the lick. Design road networks so they do not block access by moose and deer to the mineral lick site. Groundwater impacts are difficult to mitigate. The best plan is to not develop or disturb the recharge zone and leave the path between the recharge zone and the discharge zone unaltered.

Noise associated with the human activities (e.g., construction, regular maintenance) should be minimized during the season that moose are using the lick. Consider installing fencing along the edge of the development to keep people and machinery out of the habitat. If fencing is used, it is very important to ensure that it does not block wildlife movement to/from the habitat.

There are at least three aspects to consider when managing or regulating disturbance around mineral licks: (1) protection of the mineral lick site; (2) maintaining the integrity and function of the hydrological system feeding the lick (e.g., regardless of whether the development is proposed for the immediate area of the mineral lick, or adjacent lands, great care must be taken to ensure that surface water and groundwater flows and quality are not affected); and (3) minimizing disturbance in surrounding areas during peak visitation times (Rea et al. 2004). Rating the importance of the mineral lick for moose is the first in a series of steps that allows for its consideration in land development planning. How to best protect the site and maintain its integrity depends on several factors including the sensitivity of all species using the lick, the biophysical factors of the site, and the type of development planned for the area. Also the source of the mineral lick (headwaters) needs to be identified. This will help determine where development can and cannot occur.

One method that could be used to identify and classify mineral licks is based on site attributes. A field checklist, such as that developed by Rea et al. (2004), could be used to identify and describe site attributes commonly associated with mineral licks used by moose. Key site attributes for identifying and developing a site identification/classification system for wet mineral licks used by moose include: wet muddy areas or seepage; animal sightings or signs (e.g., pellets, hedged browse, tree rubs, muddy vegetation, bed sites); dense track concentrations; exposed mineral soils with clays or organic materials; trail convergence; trail use (i.e.. wear or compaction); and/or evidence of human activities (e.g., bullet casings, hunting blinds, animal remains, etc.). The degree to which site attributes are evident may vary seasonally.

Because mineral licks are rare features (Thompson and Euler 1988) and have great attraction for moose and deer, development should always avoid these areas. Ontario's 1988 "Timber Management Guidelines for the Provision of Moose Habitat" recommends a minimum buffer of 120 m around mineral licks for moose with the recognition that some development and/or extraction activities (i.e., forest harvesting) may occur under special circumstances within the buffer area. A more conservative development setback, which may be more suitable in southern Ontario where there are often a multitude of pressures on remaining habitat, is 500 m. Unlike other jurisdictions, Ontario recommends a site-specific approach to establishing buffers around a lick site that considers the forest stand and other landscape characteristics (e.g., local hydrology and topography). This includes designing the shape and extent of the buffer zone to ensure the integrity of the site and safe access for moose (OMNR 1988).

Quebec legislation defines a lick narrowly as a swamp, spring, or body of water that contains mineral salts in concentrations greater than 3 parts per million of potassium and greater than 75 parts per million of sodium. Management guidelines dictate that these sites, regardless of site specific attributes, retain a 100 m wide undeveloped reserve zone around the lick (Government of Quebec 2004).

Rea et al. (2004) suggest the following mineral lick management considerations related to the ecological characteristics and role of mineral licks used by moose (which basically summarize the management and mitigative actions listed above):

Ecology	**Management**
Seasonal use	Avoid seasonal activity peaks
Daily use	Avoid peaks in daily use
Tolerance to disturbance	Gauge habituation to human activity
Trail system	Protect: machine free zones should include habitat/trails
Soils use and biophysical aspects of lick function	Test soils for susceptibility to disturbance, compaction, and erosion
Water sources of lick	Protect: earth moving activity should not disrupt hydrological flow of lick; assess volume/flow of groundwater discharge prior to development and monitor during and after development to detect changes
Vegetation cover	Maintain cover and vegetation requirements proximate to lick

Potential Development Effects: Solar Power Facilities

If development activities within the area identified as significant wildlife habitat (the upwelling and surrounding forest cover) affect the flow of surface water or groundwater, they could easily destroy the mineral lick. Even relatively minor changes in flow rates could alter the chemistry of the lick reducing its quality and hence its usefulness to moose or deer. The risks associated with disruption of surface flow extend into adjacent lands. For instance, development on adjacent lands (e.g., site alterations such as erection of buildings or other structures, grading, filling, or excavation) could reduce infiltration and reduce or eliminate the volume of upwelling. Development also has the potential to alter the water chemistry of upwellings through contamination of surface water or groundwater. Development can also require groundwater usage (i.e. a water well). Pumping of the well for irrigation, drinking, cooling, etc. can disrupt the groundwater flow and impact groundwater discharge and therefore the lick.

Moose are intolerant of human disturbance outside of areas where they are protected, such as provincial parks. Couturier and Barrette (1988) found that moose reacted to human activity at a campground that was 2 km away from a mineral lick. Moose spent shorter periods of time at this lick than at an identical lick 5 km away from human activity. Development within the forest surrounding the upwelling will greatly reduce the use of the mineral lick particularly if human activity is increased during the spring and early summer. Activity or construction of permanent buildings within sight of the upwelling will probably lead to the abandonment of the lick by moose. Development on adjacent land would have to be relatively minor with little increase in daily activity for it to have a benign effect on mineral lick use.

Residential development often brings with it an influx of pets. Dogs in particular may disturb moose and result in abandonment of the mineral lick.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 240 m of a mineral lick should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). This distance incorporates the SWH around the lick site plus a 120 m setback of adjacent land. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and excavation for development in mineral lick SWH will destroy that portion of the habitat that is under the development footprint; human disturbance associated with the development will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

For developments adjacent to mineral lick SWH, leave a visual barrier of natural vegetation between the development and the mineral lick habitat. Alternatively, trees and shrubs could be planted to create a barrier or screen. Leave enough forested habitat around the lick to allow moose and deer to travel to and from the lick. Consider installing fencing along the edge of the development to keep people and machinery out of the habitat. If fencing is used, it is very important to ensure that it does not block wildlife movement to/from the habitat. Signage and a public education campaign may help people better understand the unique characteristics of the habitat, and the value of leaving it undisturbed. Schedule construction activities to occur when moose are not using the site.

Development on adjacent lands needs to occur in late fall or early spring when moose activity at mineral licks is minimal (Fraser and Hristienko 1981; Couturier and Barrette 1988; Rea et al., 2004) and be carried out during mid-day hours since moose use mineral licks predominantly at night (Fraser and Reardon 1980; Couturier and Barrette 1988; Rea et al. 2004). Such strategies could reduce stress and unneeded energy expenditures for moose that are sensitive to disturbance. Development needs to be planned so that increased human activity in spring and early summer does not occur within sight of the upwelling. Noise associated with the human activities (e.g., construction, regular maintenance) should be minimized at least during the season that moose are using the lick.

Design road networks so they do not block access by moose and deer to the mineral lick site. Groundwater impacts are difficult to mitigate. The best plan is to not develop or disturb the recharge zone and leave the path between the recharge zone and the discharge zone unaltered.

There are at least three aspects to consider when managing or regulating disturbance around mineral licks: (1) protection of the mineral lick site; (2) maintaining the integrity and function of the hydrological system feeding the lick (e.g., regardless of whether the development is proposed for the immediate area of the mineral lick, or adjacent lands, great care must be taken to ensure that surface water and groundwater flows and quality are not affected); and (3) minimizing disturbance in surrounding areas during peak visitation times (Rea et al. 2004). Rating the importance of the mineral lick for moose is the first in a series of steps that allows for its consideration in land development planning. How to best protect the site and maintain its integrity depends on several factors including the sensitivity of all species using the lick, the biophysical factors of the site, and the type of development planned for the area.

One method that could be used to identify and classify mineral licks is based on site attributes. A field checklist, such as that developed by Rea et al. (2004), could be used to identify and describe site attributes commonly associated with mineral licks used by moose. Key site attributes for identifying and developing a site identification/classification system for wet mineral licks used by moose include: wet muddy areas or seepage; animal sightings or signs (e.g., pellets, hedged browse, tree rubs, muddy vegetation, bed sites); dense track concentrations; exposed mineral soils with clays or organic materials; trail convergence; trail use (i.e.. wear or compaction); and/or evidence of human activities (e.g., bullet casings, hunting blinds, animal remains, etc.). The degree to which site attributes are evident may vary seasonally.

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Vegetation cover	Maintain cover and vegetation requirements proximate to lick

ROAD DEVELOPMENT

Potential Development Effects

Roads have the potential to directly destroy mineral licks when the footprint of the road is placed directly over or immediately adjacent to the lick. Roads may also act as barriers to movement of surface water and shallow groundwater, thus potentially increasing water levels on one side of the road and causing drying on the other side. Runoff from road surfaces may contain sediments and a variety of contaminants that may affect the quality of mineral licks.

Roads that are close to mineral licks may reduce their use by moose and deer if forest cover in the immediate vicinity of the lick is removed.

Roads which are placed where moose and deer must cross them to reach mineral licks present a considerable hazard to both the animals and to motorists. Significant moose and deer mortality, and potentially human injury/mortality, may result from collisions with vehicles. Salt used to de-ice roads may attract moose and deer to roadsides thus increasing the potential for collisions with vehicles.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). Mineral lick SWH includes the site plus a 120 m radius buffer around the site.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

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Retain enough forested habitat around the lick to allow moose and deer to travel to and from the lick. Route roads so they do not block access by moose and deer to the mineral lick site. Groundwater impacts are difficult to mitigate. The best plan is to not develop or disturb the recharge zone and leave the path between the recharge zone and the discharge zone unaltered.

For roads on lands adjacent to mineral lick SWH, sufficient culverts should be installed to ensure that movement of surface water and shallow groundwater under the roadbed is not impeded. If runoff from the road would flow to the mineral lick, stormwater management facilities should be constructed to detain water and sediments.

Roads should be designed so that salt pools do not form along the shoulders of the road. In Quebec, salt pools along roads were visited by moose mostly in spring and early summer before aquatic plants became widely available (Laurian et al. 2008). Potential mitigation measures for reducing moose-vehicle collisions as a result of salt pools along roads are to fill the pools with rocks (Leblond et al. 2007), increase the width of the unforested strip along the road (as moose show an aversion to crossing roads in open areas), and installation of fences along the right-of-way (Dussault et al. (2007).

INDEX #30: SEEPS AND SPRINGS

Ecoregions:	All of Ontario
Species Group:	Wild Turkey, White-tailed Deer, Ruffed Grouse, Spruce Grouse, Moose, Salamander spp.
Significant Wildlife Habitat Category:	Rare or Specialized Habitat
Functional Habitat:	Seeps and Springs
Habitat Features:	Predominantly forested (< 25% meadow/field/ pasture)

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Seepage areas, springs, and small intermittent streams may provide valuable wildlife habitat, and they may also contribute to fish habitat. Many of these occur in forests that are otherwise dry, and therefore they may increase species diversity within the forest. These habitats are particularly important to wildlife in winter as seeps and springs typically do not freeze. Consequently, they provide a source of drinking water for many wildlife species, including Wild Turkey, White-tailed Deer, Ruffed Grouse and Spruce Grouse. Because seeps and springs are typically free of snow, they also provide access to winter greens and seeds. In early spring, seeps are one of the first areas where vegetation grows. Thus, this food source is available at a critical time of year when most other food sources have been depleted.

The moist environment around seeps and springs often supports a rich community of grasses, succulent forage plants and invertebrates. The slow-moving water typical of seeps, and the availability of plant and insect food, attracts a variety of amphibians, including 5 species of salamander. Some seeps and springs are rich in minerals and may provide "salt licks" for ungulates (see topic about Mineral Licks).

Seeps and springs are groundwater discharge areas which can often be found within the headwater areas of forested habitats. Any forested site within the headwater areas of a stream could have seeps/springs. A frequent source of seeps and springs is adjacent hills or upland tablelands that perform a groundwater recharge function. These are typically areas of permeable soils such as sands or gravels that allow rapid infiltration of precipitation into the soils. This groundwater may then form a seep or spring in an area that is at a lower elevation than the adjacent uplands.

Seeps and springs also may occur on hillsides and these are often due to the lower elevation of the hillside intercepting the water table. These may be similar to those areas adjacent to recharge areas, or they may be in deeper valleys that cut into the water table without having a recharge area within the immediate vicinity.

Seeps and springs may also be a result of karst topography. Karst topography is a landscape shaped by the dissolution of soluble bedrock, usually carbonate rock such as limestone or dolomite. Due to subterranean drainage, there may be very limited surface water. Many karst regions display distinctive surface features, with sinkholes or dolines being the most common. However, distinctive karst surface features may be completely absent where the soluble rock is mantled by glacial debris, or confined by a superimposed non-soluble rock strata. The upper surface of karst topography is defined as epikarst, which consists of a network of intersecting fissures and cavities that collect and transport surface water and nutrients underground. Epikarst depth can range from a few centimetres to tens of metres. Beneath the surface, complex underground drainage systems such as karst aquifers and extensive caves and cavern systems may form. These essentially act as underground "pipes". In Ontario, most karst topography is associated with the Niagara Escarpment.

Seeps and springs in karst topography may receive water from both the groundwater aquifer and the epikarst. This provides a regular source of water for seeps and springs. Sinkholes, where they exist, may provide another more immediate source of water. Sinkholes are in areas close to the bedrock surface and they drain into a hole in the bedrock. Some sinkholes may have intermittent tributaries run into them, and these tributaries may have large watersheds. Others simply collect local surface water and precipitation. Sinkholes provide an intermittent source of water to seeps and springs, but can greatly augment their volume during spring runoff. Karst features may support seepages or springs that are ephemeral, running only briefly during spring melt or during significant precipitation events, or they may support permanent springs and watercourses. In some cases, karst features may give rise to significant coldwater streams that simply appear out of the ground.

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Development in a seep or spring is likely to result in the destruction of the specialized functions of the habitat. In some cases, it is possible that development at the source of a seep or spring will result in the relocation of the point of discharge farther down gradient. Additional studies would be required to determine if the seep or spring would still be viable in these cases.

Development on adjacent lands (i.e., the spring or seep headwaters) has the potential to affect seeps and springs. Development that occurs in recharge areas that are the source of water for the seep or spring may result in decreased flows of water or the loss of the seep or spring. Development that is an adjacent areas that are down gradient of the seep or spring may have little or no impact.

Seeps or springs that occur as a result of karst features may be adversely affected if sinkholes or other epikarst features are covered up or blocked. In areas of shallow soils over bedrock, underground conduits may be affected by installation of services or by blasting, and this in turn could affect the seep or spring.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC forest ecosite containing the seeps/springs is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and excavation for development in seeps and springs SWH will destroy the affected habitat; human disturbance associated with the development will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

For developments adjacent to seeps and springs SWH, leave a visual barrier of natural vegetation between the development and the habitat. Retain enough forested habitat around the seep/spring SWH to allow wildlife to travel to and from the site. Consider installing fencing along the edge of the development to discourage people, pets and ATVs from using the habitat. If fencing is used, it is very important to ensure that it does not block wildlife movements to/from the habitat. Signage and a public education campaign may help people better understand the unique characteristics of the habitat, and the value of leaving it undisturbed. Schedule construction activities to occur when the site is not in use.

When development is planned near a seep or spring, it will be necessary to determine the source of water and how it may be affected by the development and subsequently impact the seep or spring.

For housing or cottage development in tablelands that are functioning as a recharge area, there are mitigation measures that may be used to lessen the effect of creating additional impervious surfaces. These may include directing downspouts onto lawns, collecting stormwater in swales and in roadside ditches as opposed to curbs and drains, and using bricks in driveways instead of paving. In certain areas, it may be possible to use infiltration as part of the stormwater management collection and treatment system. Where soils are appropriate, stormwater collectors can be porous or have holes in them so that they leak water into the substrate. In some subdivisions, the entire stormwater system is based on infiltration so that water rarely leaves the site and almost all of it returns to the water table. For developments where adjacent seeps and springs are an issue, it will be necessary to complete a water balance study to demonstrate that the mitigation measures will be effective in maintaining groundwater flows. Both hydrological and hydro-geological studies may be required. It will also be necessary to demonstrate that water quality, including temperature, in the seep or spring will not be adversely affected. It is important to preserve the flow of the karstic system and it is key to ensure proper flushing of the system to prevent accumulation of silt and debris in the conduits.

Where karst features are involved, it may be necessary to conduct detailed hydro-geological and karst studies to determine the source of water for the seeps or springs. This may entail conducting dye tracer tests to determine which sinkholes contribute water to the seeps or springs. Development should never directly affect sinkholes or other important epikarst features, and it will be necessary to develop buffers around them to ensure that water quality that enters the conduits is not degraded. A water balance study will be required to demonstrate that water quality and quantity will not be significantly affected. Hydrological studies will also be necessary to understand the extent of flooding in the vicinity of sinkholes in the spring, and the locations of any intermittent tributaries that may be present.

In some areas, water pipes for wildlife (guzzlers) have been installed to compensate for dewatered seeps and springs (e.g., in BC's Okanagan), however Ontario's climate may prohibit such mitigation. This should only be considered as a last resort.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Seeps or springs could potentially be affected by developing ski runs or by golf courses.

Development in a seep or spring is likely to result in the destruction of the specialized functions of the habitat. In some cases, it is possible that development at the source of a seep or spring will result in the relocation of the point of discharge farther down gradient. Additional studies would be required to determine if the seep or spring would still be viable in these cases.

Development on adjacent lands has the potential to affect seeps and springs. Development that occurs in recharge areas that are the source of water for the seep or spring may result in decreased flows of water or the loss of the seep or spring.

Seeps or springs that occur as a result of karst features may be adversely affected if sinkholes or other epikarst features are covered up or blocked. In areas of shallow soils over bedrock, underground conduits may be affected by installation of services or by blasting, and this in turn could affect the seep or spring.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC forest ecosite containing the seeps/springs is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in seeps and springs SWH will destroy the affected habitat; human disturbance associated with the development will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

When development is planned near a seep or spring, it will be necessary to determine the source of water and how it may be affected by the development and subsequently impact the seep or spring.

For recreational development in lands that are functioning as a recharge area (usually an area of hummocky topography), there are mitigation measures that may be used to lessen the effect of creating additional impervious surfaces. These may include directing downspouts onto lawns, collecting stormwater in swales and in roadside ditches as opposed to curbs and drains, and using unconsolidated materials in parking lots instead of paving. In certain areas, it may be possible to use infiltration as part of the stormwater management collection and treatment system. Where soils are appropriate, stormwater collectors can be porous or have holes in them so that they leak water into the substrate.

For developments where adjacent seeps and springs are an issue, it will be necessary to complete a water balance study to demonstrate that the mitigation measures will be effective in maintaining groundwater flows. Both hydrological and hydro-geological studies may be required. It will also be necessary to demonstrate that water quality in the seep or spring will not be adversely affected.

Where karst features are involved, it may be necessary to conduct detailed hydro-geological and karst studies to determine the source of water for the seeps or springs. This may entail conducting dye tests to determine which sinkholes and other epikarst features contribute water to the seeps or springs. Development should never directly affect sinkholes and other key epikarst features, and it will be necessary to develop buffers around them to ensure that water quality that enters the conduits is not degraded. A water balance study will be required to demonstrate that water quality and quantity will not be significantly affected. Hydrological studies will also be necessary to understand the extent of flooding in the vicinity of sinkholes in the spring, and the locations of any intermittent tributaries that may be present.

Golf courses planned for areas that contain sinkholes will have to be carefully designed. Appropriate buffers will have to be established around each sinkhole to ensure that excessive nutrients, sediments, and pesticides do not reach significant seeps or springs downstream. Depending upon the significance of the downstream spring, it may be necessary to conduct a nutrient loading model to determine potential impacts of the golf course on aquatic habitat. In sensitive watersheds, an Integrated Management Plan be prepared for the golf course. This will include information on how and when fertilizers and pesticides will be applied and will document the irrigation regime for the golf course. Mitigation measures designed to protect sinkholes and the quantity and quality of water that enters them needs to be identified for all possible scenarios.

In some areas, water pipes for wildlife (guzzlers) have been installed to compensate for dewatered seeps and springs (e.g., in BC's Okanagan), however Ontario's climate may prohibit such mitigation. This should only be considered as a last resort.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Seeps and springs may also be affected by aggregate extraction. Sand and gravel pits are often recharge areas and removal of this material may affect the amount of groundwater that flows towards seeps or springs. Quarries have the potential to intercept underground karst conduits and cut off the water supply to seeps and springs. Pits and quarries where extraction occurs below the groundwater table may require dewatering during the extraction phase. The local lowering of the water table has the potential to affect flows in seeps and springs.

Similarly, dewatering for mining activity may result in loss of seeps and springs due to lack of hydraulic head. Even changes to flow may have significant impacts.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC forest ecosite containing the seeps/springs is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in seeps and springs SWH will destroy the affected habitat; human disturbance associated with the development will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

For developments adjacent to seeps and springs SWH, leave a visual barrier of natural vegetation between the development and the habitat. Retain enough forested habitat around the seep/spring SWH to allow wildlife to travel to and from the site. Schedule construction activities to occur when the site is not in use.

For aggregate extraction operations, it may be possible to direct dewatering areas first to a settling pond and then to an infiltration basin that will recharge the seeps or springs. Hydro-geological studies will be required to determine impacts upon seeps or springs. It may not be possible to mitigate the impacts of extraction below the water table on seeps or springs during the operation phase of a pit or quarry. In these cases, the significance of the aggregate resources must be weighed against the significance of the seeps and springs, as both features are considered worthy of protection or use under the Provincial Policy Statement. In some cases, seeps and springs might be maintained by pumping into artificial recharge wells or by establishing an impermeable barrier around the pit or quarry. The effectiveness of this type of mitigation has, however, yet to be tested in the field.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Clearing for development in mineral lick habitat will remove critical cover elements of the habitat.

The ecological function of seeps and springs habitat may also be affected by development on adjacent lands. Construction, operational noise and maintenance activities may disturb wildlife using the habitat, access roads may block animals from reaching the site, and the development may change the hydrology of the area which is critical to seeps and springs habitat. A change in the hydrology of the habitat could destroy seeps and springs sites. Additionally, clearing of forested habitat adjacent to or around seeps and springs habitat may block wildlife from reaching the site.

Moose are intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Human activities associated with construction and turbine maintenance will likely disturb moose (and other wildlife) using the seeps and springs if they are within visual range. Moose are also known to respond to noise in the environment, e.g., noise pollution and disturbance are listed as threats in Nova Scotia's recovery plan for mainland moose (NSDNR 2007). However, little seems to be known about moose responses to turbine noise in particular, or to the physical movement of turbines during operation. In a study of behavioural and physiological responses by moose to noise disturbance at a military site in Norway, Anderson et al. (1996) concluded that sources of disturbance identifiable by moose as human elicited flight responses at greater distances and elevated heart rates for longer periods than disturbances that were recognized as mechanical. This study was conducted in the fall; the authors caution that the same level of disturbance in the winter or during calving could have more detrimental effects.

Moose are known to avoid roads (AMEC Americas Limited 2005). Access roads may block moose from reaching seeps and springs habitat.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the edge of an ELC ecosite that contains seeps and springs SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. The area of the ELC forest ecosite containing the seeps/springs is the SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in seeps and springs SWH will destroy the affected habitat; human disturbance associated with the development will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

For developments adjacent to seeps and springs SWH, leave a visual barrier of natural vegetation between the development and the habitat. Retain enough forested habitat around the seep/spring SWH to allow wildlife to travel to and from the site. Schedule construction activities to occur when the site is not in use. Design road networks so they do not block access by wildlife to the seeps and springs habitat.

Groundwater impacts are difficult to mitigate. The best plan is to not develop or disturb the recharge zone and leave the path between the recharge zone and the discharge zone unaltered.

Noise associated with the human activities (e.g., construction, regular maintenance) should be minimized during the period when the seeps and springs habitat is in use.

Potential Development Effects: Solar Power Facilities

Development in a seep or spring is likely to result in the destruction of the specialized functions of the habitat. In some cases, it is possible that development at the source of a seep or spring will result in the relocation of the point of discharge farther down gradient. Additional studies would be required to determine if the seep or spring would still be viable in these cases.

Development on adjacent lands (i.e., the spring or seep headwaters) has the potential to affect seeps and springs. Development that occurs in recharge areas that are the source of water for the seep or spring may result in decreased flows of water or the loss of the seep or spring. Development that is an adjacent areas that are down gradient of the seep or spring may have little or no impact.

Seeps or springs that occur as a result of karst features may be adversely affected if sinkholes or other epikarst features are covered up or blocked. In areas of shallow soils over bedrock, underground conduits may be affected by installation of services or by blasting, and this in turn could affect the seep or spring.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of the edge of an ELC ecosite that contains seeps and springs SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The area of the ELC forest ecosite containing the seeps/springs is the SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and excavation for development in seeps and springs SWH will destroy that portion of the habitat that is under the development footprint; human disturbance associated with the development will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

For developments adjacent to seeps and springs SWH, leave a visual barrier of natural vegetation between the development and the habitat. Retain enough forested habitat around the seep/spring SWH to allow wildlife to travel to and from the site. Consider installing fencing along the edge of the development to discourage people, pets and ATVs from using the habitat. If fencing is used, it is very important to ensure that it does not block wildlife movements to/from the habitat. Signage and a public education campaign may help people better understand the unique characteristics of the habitat, and the value of leaving it undisturbed. Schedule construction activities to occur when the site is not in use. Design road networks so they do not block access by wildlife to the seeps and springs habitat.

Noise associated with the human activities (e.g., construction, regular maintenance) should be minimized during the period when the seeps and springs habitat is in use.

Groundwater impacts are difficult to mitigate. The best plan is to not develop or disturb the recharge zone and leave the path between the recharge zone and the discharge zone unaltered. When development is planned near a seep or spring, it will be necessary to determine the source of water and how it may be affected by the development and subsequently impact the seep or spring.

For developments where adjacent seeps and springs are an issue, it will be necessary to complete a water balance study to demonstrate that the mitigation measures will be effective in maintaining groundwater flows. Both hydrological and hydro-geological studies may be required. It will also be necessary to demonstrate that water quality, including temperature, in the seep or spring will not be adversely affected. It is important to preserve the flow of the karstic system and it is key to ensure proper flushing of the system to prevent accumulation of silt and debris in the conduits.

Where karst features are involved, it may be necessary to conduct detailed hydro-geological and karst studies to determine the source of water for the seeps or springs. This may entail conducting dye tracer tests to determine which sinkholes contribute water to the seeps or springs. Development should never directly affect sinkholes or other important epikarst features, and it will be necessary to develop buffers around them to ensure that water quality that enters the conduits is not degraded. A water balance study will be required to demonstrate that water quality and quantity will not be significantly affected. Hydrological studies will also be necessary to understand the extent of flooding in the vicinity of sinkholes in the spring, and the locations of any intermittent tributaries that may be present.

In some areas, water pipes for wildlife (guzzlers) have been installed to compensate for dewatered seeps and springs (e.g., in BC's Okanagan), however Ontario's climate may prohibit such mitigation. This should only be considered as a last resort.

ROAD DEVELOPMENT

Potential Development Effects

Road development in seeps and springs habitat will result in the destruction of the specialized functions of the habitat. In some cases, it is possible that construction of a road at the source of a seep or spring will result in the relocation of the point of discharge farther down gradient. Additional studies would be required to determine if the seep or spring would still be viable in these cases.

Development on adjacent lands also has the potential to affect seeps and springs. Roads may act as a barrier to the movement of surface water and shallow groundwater or may redirect this flow away from the original discharge zone. This can result in one side of the road becoming drier and the other wetter. The presence of a road near a seep or spring has the potential to cut off the source of water to that feature. Roads upstream of a seep or spring may deliver surface water runoff that contains an excess of nutrients, sediments, and other contaminants.

Seeps or springs that occur as a result of karst features may be adversely affected by a new road if sinkholes or other significant epikarst features are covered up or blocked. In areas of shallow soils over bedrock, underground conduits may be affected by digging roadside ditches, installation of services, or by blasting, and this in turn could affect the seep or spring.

Roads that are close to seeps and springs habitat may reduce their use by wildlife if forest cover in the immediate vicinity of the habitat is removed.

Roads which are placed where moose and deer must cross them to reach mineral licks present a considerable hazard to both the animals and to motorists. Significant moose and deer mortality, and potentially human injury/mortality, may result from collisions with vehicles.

Salt used to de-ice roads may attract moose and deer to roadsides thus increasing the potential for collisions with vehicles.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC forest ecosite containing the seeps/springs is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in seeps and springs SWH will destroy the affected habitat; human disturbance (vehicle and pedestrian) associated with the development will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

For road development on lands adjacent to seeps and springs habitat, adequate culverts should be installed to ensure continued unimpeded flow of surface water and shallow ground water. Where runoff from a road may be directed overland to a seep or spring, stormwater management facilities should be installed to capture excessive nutrients, sediments and other contaminants.

If at all possible, areas containing sinkholes and other karst features should always be avoided by new roads. When these general areas cannot be avoided, attempts should be made to avoid individual sinkholes and other significant epikarst features. The extent of each significant epikarst feature's watershed should be determined along with the locations of any intermittent tributaries that may be present. The extent of flooding associated with each sinkhole and major epikarst feature during spring freshet should also be determined. Ideally, roads would be constructed outside of sinkhole and major epikarst feature floodplains and major sources of water for them. Roads definitely not be constructed where they will have a direct impact on sinkholes as this will have a negative impact on the habitat.

If roads will be situated in karst topography, appropriate stormwater management facilities will be required to be constructed and maintained so that contaminants from the road surface do not flow into underground conduits. Depth to bedrock should be determined in the area where the road is to be constructed. In areas of karst topography, roads should not be constructed where the weight of them or associated services and ditches may intercept or crush underground karst conduits.

INDEX #31: MAMMAL DENNING SITES

Ecoregions:	3E, 5E
Species Group:	Mink, Otter, Marten, Fisher, Eastern Wolf (SPECIAL CONCERN)
Significant Wildlife Habitat Category:	Rare or Specialized Habitat
Functional Habitat:	Preferred Habitat

DEVELOPMENT TYPES IN THIS INDEX

Mustelids
Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development
Eastern Wolf
Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

The mink, otter, fisher and marten are all members of the weasel family (Mustelidae). They are active predators, with large home ranges in which to search for food. A male fisher may have a home range of 17.5 to 39 sq. km) (OMNR 2000). Mustelids are rarely found in high densities, and have specific habitat components critical to their survival.

Mink prefer shorelines dominated by coniferous or mixed forests for feeding and denning. Dens are usually located underground, especially where shrubs and deadfalls provide cover and habitat for prey (OMNR 2000). They also den in abandoned muskrat lodges, holes in stone piles and beneath large tree roots (OMNR 1986); dens are usually near water and may have more than one entrance. All dens are temporary, as the Mink moves frequently (eNature 2007). Otters require undisturbed shorelines with abundant shrubby vegetation and downed woody debris; they often use old beaver lodges, log jams, and crevices in rock piles for denning. Since otters eat primarily fish (OMNR 1986), they require shoreline habitats that support large, productive fish populations.

Marten and fisher share the same general habitat requirements – large, unbroken tracts of coniferous or mixed forest with abundant large trees for denning sites. Areas with the least disturbance are the most significant (OMNR 2000). Martens require habitat with mature and over-mature forests, cavity trees, and coarse woody debris; complex physical structure near the ground is important (OMNR 2008b). Marten survival and production rates are higher in old growth forests than in post-clearcut forests (Thompson and Colgan 1994). Vertical and horizontal structure is most important (Chapin et al. 1997). Marten often use cavities originally made by woodpeckers (OMNR 2000), but they will also use a hollow log or stump (Racey and Hessey 1989), a pile of brush, or a rock slide for establishing a den (OMNR 2007b). In Ontario, Lancaster et al. (2008) found fisher abundance to be positively correlated with the proportion of the landscape that was forested. In British Columbia, structural habitat features important to fishers include coarse woody debris (downed logs, stumps, litter), snags, and multiple layers of overhead vegetation (shrubs, saplings, trees), all of which provide cover for both fishers and their various prey (Hatler et al. 2003). Fisher dens are usually in areas having high structural diversity (Hatler et al. 2003), in the cavities of dead or living trees (> 50 cm diameter at breast height preferred), in fallen logs or openings in rock ledges (Racey and Hessey 1989).

The Eastern Wolf inhabits deciduous and mixed forests in the southern part of its range, and mixed and coniferous forests further north (Environment Canada 2007b). Like the mustelids, wolves are active predators with large home ranges (OMNR 2005a). Dens are excavated into well-drained sandy knolls or hillsides, hollow logs or stumps, or established in rock caves; in all cases, dens are often near water (OMNR 2005a). Dens are used primarily for rearing pups, but adults will also use dens for shelter from weather and insects. Any given den may not be used in consecutive years, but re-use over a period of years is common. Wolves tend to show high fidelity to den sites (OMNR 2008a). Traditionally used sites can be identified by extensive tunneling, large-diameter entrance holes, and plenty of prey bones and wolf scat (OMNR 2005a).

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Mustelids

Potential Development Effects

Developments that alter shoreline habitat, such as residences (including cottages) and marinas, can have an impact on mink and otter denning habitat. Racey and Euler (1983) found a significant negative correlation between mink density and intensity of cottage development on lakes in central Ontario. Mink dens occurred in areas with higher than average shrub densities, deadfalls, stumps and trees; all of these elements were reduced on developed shorelines by lot clearing and the introduction of non-native plant species. Shoreline development also simplified the littoral zone by the removal of snags, large boulders, and aquatic vegetation. These changes in vegetation composition and habitat structure had a significant impact on the species composition and abundance of the mink's terrestrial and aquatic prey.

High quality aquatic habitats that produce an abundance of fish, frogs and a variety of aquatic invertebrates are required for otters (OMNR 1986, 2000). Shoreline simplification due to clearing, beach development and dock installation will negatively affect the species composition and abundance of aquatic prey species. Prey abundance may also be depressed by reduced water quality as a result of pollution from faulty septic systems and power boats. Reduced prey abundance and species richness may in turn reduce the quality of the habitat for denning otters and mink. Additionally, because otters spend much of their time in the water, and find most of their food in the water, they are at risk of being directly harmed by water pollution; otters are not tolerant of polluted ecosystems (NYSDEC 2010a). Toxins taken up by prey species accumulate in the tissues of top predators, causing a variety of health effects. Environmental contaminants are known to cause weight loss and reproductive problems in captive mink, but the impact on wild mink is not known (NYSDEC 2010b).

Commercial mink farming is known to have negative impacts on wild mink through predation, resource competition and the introduction of disease (Kidd et al. 2009). Additionally, hybridization between domestic and wild conspecifics threatens the future sustainability of wild mink populations by disrupting local genetic adaptations and population structure. Kidd et al. (2009) found that 64% of the mink sampled in 2 populations near mink farms in Ontario were either farm escapees or escapee descendents.

Mammalian carnivores are particularly vulnerable to extinction in fragmented landscapes (Woodroffe and Ginsberg 1998). Species most at risk are the ones that range widely, and are therefore most exposed to threats on reserve borders. Any development that reduces or fragments mature forests will have a negative impact on mustelids, e.g., intensive cottage and housing developments on wooded sites. Fisher avoid recently cleared areas, probably because they lack cover for dens and prey species (de Vos 1952, in Racey and Hessey 1989). Clearcutting within mature coniferous or mixed forest reduces marten densities and increases home range size (Thompson and Colgan 1987) in response to changes in prey species composition and abundance. For example, it typically takes up to 7 years for snowshoe hare to re-colonize cutover habitat, with peak use taking up to 20 years to occur (Litvaitis et al. 1985). Fisher also appear to respond numerically to changes in snowshoe hare abundance (Bowman et al. 2006); reduced hare abundance correlates with reduced fisher abundance. Clearcutting in spruce-dominated boreal forests also results in marked changes in the small mammal community, with red-backed voles being replaced as the dominant small mammal by species less preferred by marten as prey (OMNR 1996). Marten densities can remain low in clearcut habitats for up to 40 years (Soutiere 1979; Steventon and Major 1982; Snyder and Bissonette 1987), and marten mortality in clearcuts is also "markedly higher" than in uncut forests (Thompson 1994).

Residential (including cottage) and commercial developments are also associated with increased human activity. Human activity in fisher habitat increases the potential for human-fisher conflicts. Fishers have been reported to take domestic fowl, feral cats and dogs, and small pets that have been left outdoors. Additionally, all of the mustelids in this index are valued for their pelts; more people may result in more trapping (OMNR 1986). Human activity within the vicinity of dens may also affect use by some species (OMNR 2008a).

The road networks that typically accompany residential and commercial developments further fragment the habitat, and increase mortality through vehicle strikes (see about Road Development, below).

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes any known active denning site plus a 20 m radius of undisturbed habitat around it.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Shoreline alteration and forest clearing within mammal denning SWH will reduce or destroy the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat.

The Significant Wildlife Habitat Technical Guide (OMNR 2000) recommends that den sites for marten and fisher, and adjacent forested habitat, should be protected from development. When a significant wildlife habitat feature is part of a larger natural area, it is difficult to quantify the amount of habitat that needs to be protected. For marten and fisher dens, protecting as much well-connected habitat around each site provides better protection to the feature and its ecological function than the application of buffer zones. As many large blocks of contiguous mid-aged to mature forest around the den site as possible should be protected; even more area (an additional 100 m) may be required if disturbance is likely to be a problem.

For development on lands adjacent to mammal denning SWH, site the development as far as possible from the SWH. Minimize shoreline alteration at the development by retaining as much of the original shoreline structure as possible (e.g., snags and downed woody debris). High quality aquatic habitats that produce an abundance of fish, crustaceans and insects are a very important component of mammal denning habitat. Natural, undisturbed habitats are best. Minimize the amount of forested habitat that is cleared for the development; this option may help reduce the effects of habitat fragmentation for marten and fisher.

Mitigation against the impacts of commercial mink farming on wild mink includes ensuring that effective biosecurity practices are in place at mink farms. Kidd et al. (2009) suggested that a licensing mechanisms for mink farms may be needed to achieve improved biosecurity in Ontario. Although eradication of feral mink through hunting has been effective in some overseas jurisdictions, this approach may be inappropriate in Ontario where, at least in the mink populations observed by Kidd et al. (2009), there is a high level of feral-wild hybridization that would make it difficult to accurately target just feral individuals.

Eastern Wolf

Potential Development Effects

Eastern wolves are timid and easily disturbed by human activity (Parks Canada 2009). Residential and commercial developments increase human activity in and around the developed area. Increased human activity in Eastern Wolf habitat increases the probability of human-wolf conflicts, resulting in wolf mortality through such means as hunting, trapping and vehicle strikes (OMNR 2005a; Environment Canada 2007b; Parks Canada 2009). Many people view wolves as a threat to domestic animals and public safety, and as competition for big game (white-tailed deer, moose) and furbearers (beaver) (OMNR 2005a). In a study of gray wolves inhabiting the Pukaskwa/White River Forest region, 47% of wolf mortality was human-caused (Forshner 2002, in Theberge 2002).

Mammalian carnivores are particularly vulnerable to extinction in fragmented landscapes (Woodroffe and Ginsberg 1998). Species most at risk are the ones that range widely, and are therefore most exposed to threats on reserve borders. Developments that fragment the forest, such as human settlements and roads, threaten wolf populations by compromising travel corridors and isolating populations from neighbouring wolf range (OMNR 2005a); connectivity with adjacent range is necessary to ensure population persistence. On the other hand, openings in the forest encourage early successional vegetation growth that enhances habitat for the wolf's ungulate prey species (OMNR 1986); however, the net impact for wolves is likely to be negative if there is no protection in these areas against persecution by humans.

Losses of wolf habitat in Ontario to agriculture, logging and urban expansion are ongoing (Parks Canada 2009).

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes any known Eastern Wolf denning site plus a 200 m radius of undisturbed habitat around it.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in Eastern Wolf denning SWH will destroy the affected habitat, and fragment the habitat as a whole. Habitat fragmentation, and human disturbance associated with the development, will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

The Significant Wildlife Habitat Technical Guide (OMNR 2000) recommends that den sites for eastern wolves, and adjacent habitat, should be protected from development. When a significant wildlife habitat feature is part of a larger natural area, it is difficult to quantify the amount of habitat that needs to be protected. For wolf dens, protecting as much well-connected habitat around each site as possible provides better protection to the feature and its ecological function than the application of buffer zones.

For development on lands adjacent to Eastern Wolf denning SWH, minimize the total amount of forested habitat that is cleared for the development; this may help mitigate the impacts of habitat fragmentation. Timing development activities to occur outside the denning period may be an effective option for mitigating disturbance impacts. For example, forest management guidelines for Ontario prohibit all operations near identified wolf dens during the denning period of April 15 – July 15 in the boreal forest and April 1 – June 30 in the Great Lakes St. Lawrence forest. These restrictions apply to dens known or suspected to have been occupied by eastern wolves at least once within the last 10 years (OMNR 2008a).

Where wolves are afforded some degree of protection and prey remains abundant, they are able to inhabit areas with relatively high human activity (Mech 1993, in Buss and de Almeida 1997; OMNR 2005a). Educating people about the ecology and status of wolves can alleviate negative attitudes and reactions to wolves, and promote understanding and acceptance of wolf conservation programs. For example, wolves are timid and tend to avoid areas of human activity (Parks Canada 2009), so the number of incidents in which wolves threaten public safety is likely small (OMNR 2005a). Additionally, wolves pose a smaller threat to livestock and pets than many people believe. Most reports of domestic animal depredation can actually be attributed to coyotes rather than to wolves (Buss and de Almeida 1997; OMNR 2005a). A number of Provincial Parks currently use the wolf as a subject in their interpretive programs; the most consistent and notable interpretive programs are those of Algonquin Provincial Park (OMNR 2005a).

MAJOR RECREATIONAL DEVELOPMENT

Mustelids

Potential Development Effects

Major recreational developments that alter shoreline habitat, such as marinas and beach resorts, can have an impact on mink and otter denning habitat. Racey and Euler (1983) found a significant negative correlation between mink density and intensity of lakeshore development in central Ontario. Mink dens occurred in areas with higher than average shrub densities, deadfalls, stumps and trees; all of these elements were reduced on developed shorelines by land clearing and the introduction of non-native plant species. Shoreline development also simplified the littoral zone by the removal of snags, large boulders, and aquatic vegetation. These changes in vegetation composition and habitat structure had a significant impact on the species composition and abundance of the mink’s terrestrial and aquatic prey.

High quality aquatic habitats that produce an abundance of fish, frogs and a variety of aquatic invertebrates are required for otters (OMNR 1986, 2000). Shoreline simplification due to clearing and beach development will negatively affect the species composition and abundance of aquatic prey species. Reduced prey abundance and species richness may in turn reduce the quality of the habitat for denning otters and mink. Additionally, because otters spend much of their time in the water, and find most of their food in the water, they are at risk of being directly harmed by water pollution; otters are not tolerant of polluted ecosystems (NYSDEC 2010a). Toxins taken up by prey species accumulate in the tissues of top predators, causing a variety of health effects. Environmental contaminants are known to cause weight loss and reproductive problems in captive mink, but the impact on wild mink is not known (NYSDEC 2010b).

Mammalian carnivores are particularly vulnerable to extinction in fragmented landscapes (Woodroffe and Ginsberg 1998). Species most at risk are the ones that range widely, and are therefore most exposed to threats on reserve borders. Any development that reduces or fragments mature forests will have a negative impact on mustelids. Fisher avoid recently cleared areas, probably because they lack cover for dens and prey species (de Vos 1952, in Racey and Hessey 1989). Clearcutting within mature coniferous or mixed forest reduces marten densities and increases home range size (Thompson and Colgan 1987) in response to changes in prey species composition and abundance. For example, it typically takes up to 7 years for snowshoe hare to re-colonize cutover habitat, with peak use taking up to 20 years to occur (Litvaitis et al. 1985). Fisher also appear to respond numerically to changes in snowshoe hare abundance (Bowman et al. 2006); reduced hare abundance correlates with reduced fisher abundance. Clearcutting in spruce-dominated boreal forests also results in marked changes in the small mammal community, with red-backed voles being replaced as the dominant small mammal by species less preferred by marten as prey (OMNR 1996). Marten densities can remain low in clearcut habitats for up to 40 years (Soutiere 1979; Steventon and Major 1982; Snyder and Bissonette 1987), and marten mortality in clearcuts is also "markedly higher" than in uncut forests (Thompson 1994).

Ski runs developed in the traditional manner, i.e., wide swaths that are completely cleared of trees and shrubs, result in a high degree of habitat fragmentation (Hadley and Wilson 2004). Clearcutting has been shown to have a negative impact on the abundance, reproduction and survival of red-backed voles, a preferred food for marten (Sullivan and Sullivan 2001; Hadley and Wilson 2004). An experimental study at Vail Ski Area in Colorado concluded that forest carnivores dependant on red-backed voles for prey, e.g., boreal owls and American marten, may respond negatively to ski run development (Hadley and Wilson 2004).

Major recreational developments are also associated with increased human activity. Human activity in fisher habitat increases the potential for human-fisher conflicts. Fishers have been reported to take domestic fowl, feral cats and dogs, and small pets that have been left outdoors. Additionally, all of the mustelids in this index are valued for their pelts; more people may result in more trapping (OMNR 1986). Human activity within the vicinity of dens may also affect use by some species (OMNR 2008a).

The road networks that typically accompany major recreational developments further fragment the habitat, and increase mortality through vehicle strikes (see about Road Development, below).

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes any known active denning site plus a 20 m radius of undisturbed habitat around it.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Shoreline alteration and forest clearing within mammal denning SWH will reduce or destroy the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat.

The Significant Wildlife Habitat Technical Guide (OMNR 2000) recommends that den sites for marten and fisher, and adjacent forested habitat, should be protected from development. When a significant wildlife habitat feature is part of a larger natural area, it is difficult to quantify the amount of habitat that needs to be protected. For marten and fisher dens, protecting as much well-connected habitat around each site provides better protection to the feature and its ecological function than the application of buffer zones. As many large blocks of contiguous mid-aged to mature forest around the den site as possible should be protected; even more area (an additional 100 m) may be required if disturbance is likely to be a problem.

For development on lands adjacent to mammal denning SWH, site the development as far as possible from the SWH. Minimize shoreline alteration at the development by retaining as much of the original shoreline structure as possible (e.g., snags and downed woody debris). High quality aquatic habitats that produce an abundance of fish, crustaceans and insects are a very important component of mammal denning habitat. Natural, undisturbed habitats are best. As much as possible, minimize the amount of forested habitat that is cleared for the development; this option may help reduce the effects of habitat fragmentation for marten and fisher.

Sullivan and Sullivan (2001) found that the abundance of red-backed voles, a preferred food of the American marten, was positively related to the density of residual trees after harvest. At Vail Ski Area in Colorado, Hadley and Wilson (2004) showed that red-backed voles will, at least in the short-term, inhabit ski runs with tree islands and woody debris. These authors concluded that developing primarily narrower, gladed runs may decrease the impacts of ski resort development on wildlife.

Eastern Wolf

Potential Development Effects

Eastern wolves are timid and easily disturbed by human activity (Parks Canada 2009). Major recreational developments, such as hunting lodges and ski resorts, increase human activity in and around the developed area. Increased human activity in Eastern Wolf habitat increases the probability of human-wolf conflicts, resulting in wolf mortality through such means as hunting, trapping and vehicle strikes (OMNR 2005a; Environment Canada 2007b; Parks Canada 2009). Many people view wolves as a threat to domestic animals and public safety, and as competition for big game (white-tailed deer, moose) and furbearers (beaver) (OMNR 2005a). In a study of gray wolves inhabiting the Pukaskwa/White River Forest region, 47% of wolf mortality was human-caused (Forshner 2002, in Theberge 2002).

Mammalian carnivores are particularly vulnerable to extinction in fragmented landscapes (Woodroffe and Ginsberg 1998). Species most at risk are the ones that range widely, and are therefore most exposed to threats on reserve borders. Developments that fragment the forest threaten wolf populations by compromising travel corridors and isolating populations from neighbouring wolf range (OMNR 2005a); connectivity with adjacent range is necessary to ensure population persistence. On the other hand, openings in the forest encourage early successional vegetation growth that enhances habitat for the wolf's ungulate prey species (OMNR 1986); however, the net impact for wolves is likely to be negative if there is no protection in these areas against persecution by humans.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes any known Eastern Wolf denning site plus a 200 m radius of undisturbed habitat around it.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in Eastern Wolf denning SWH will destroy the affected habitat, and fragment the habitat as a whole. Habitat fragmentation, and human disturbance associated with the development, will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

The Significant Wildlife Habitat Technical Guide (OMNR 2000) recommends that den sites for eastern wolves, and adjacent habitat, should be protected from development. When a significant wildlife habitat feature is part of a larger natural area, it is difficult to quantify the amount of habitat that needs to be protected. For wolf dens, protecting as much well-connected habitat around each site as possible provides better protection to the feature and its ecological function than the application of buffer zones.

For development on lands adjacent to Eastern Wolf denning SWH, minimize the total amount of forested habitat that is cleared for the development; this may help mitigate the impacts of habitat fragmentation. Timing development activities to occur outside the denning period may be an effective option for mitigating disturbance impacts. For example, forest management guidelines for Ontario prohibit all operations near identified wolf dens during the denning period of April 15 – July 15 in the boreal forest and April 1 – June 30 in the Great Lakes St. Lawrence forest. These restrictions apply to dens known or suspected to have been occupied by eastern wolves at least once within the last 10 years (OMNR 2008a).

Where wolves are afforded some degree of protection and prey remains abundant, they are able to inhabit areas with relatively high human activity (Mech 1993, in Buss and de Almeida 1997; OMNR 2005a). Educating people about the ecology and status of wolves can alleviate negative attitudes and reactions to wolves, and promote understanding and acceptance of wolf conservation programs. For example, wolves are timid and tend to avoid areas of human activity (Parks Canada 2009), so the number of incidents in which wolves threaten public safety is likely small (OMNR 2005a). Additionally, wolves pose a smaller threat to livestock and pets than many people believe. Most reports of domestic animal depredation can actually be attributed to coyotes rather than to wolves (Buss and de Almeida 1997; OMNR 2005a). A number of Provincial Parks currently use the wolf as a subject in their interpretive programs; the most consistent and notable interpretive programs are those of Algonquin Provincial Park (OMNR 2005a).

AGGREGATE AND MINE DEVELOPMENT

Mustelids

Potential Development Effects

Mammalian carnivores are particularly vulnerable to extinction in fragmented landscapes (Woodroffe and Ginsberg 1998). Species most at risk are the ones that range widely, and are therefore most exposed to threats on reserve borders. Any development that reduces or fragments mature forests will have a negative impact on mustelids. Fisher avoid recently cleared areas, probably because they lack cover for dens and prey species (de Vos 1952, in Racey and Hessey 1989). Clearcutting within mature coniferous or mixed forest reduces marten densities and increases home range size (Thompson and Colgan 1987) in response to changes in prey species composition and abundance. For example, it typically takes up to 7 years for snowshoe hare to re-colonize cutover habitat, with peak use taking up to 20 years to occur (Litvaitis et al. 1985). Fisher also appear to respond numerically to changes in snowshoe hare abundance (Bowman et al. 2006); reduced hare abundance correlates with reduced fisher abundance. Clearcutting in spruce-dominated boreal forests also results in marked changes in the small mammal community, with red-backed voles being replaced as the dominant small mammal by species less preferred by marten as prey (OMNR 1996). Marten densities can remain low in clearcut habitats for up to 40 years (Soutiere 1979; Steventon and Major 1982; Snyder and Bissonette 1987), and marten mortality in clearcuts is also "markedly higher" than in uncut forests (Thompson 1994).

Roads that accompany development further fragment the habitat, and increase mortality through vehicle strikes (see about Road Development, below).

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNR 2014). The SWH includes any known active denning site plus a 20 m radius of undisturbed habitat around it.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Forest clearing within mammal denning SWH will fragment the habitat and reduce or destroy its ecological function. Human disturbance associated with an active aggregate site will further reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

The Significant Wildlife Habitat Technical Guide (OMNR 2000) recommends that den sites for marten and fisher, and adjacent forested habitat, should be protected from development. When a significant wildlife habitat feature is part of a larger natural area, it is difficult to quantify the amount of habitat that needs to be protected. For marten and fisher dens, protecting as much well-connected habitat around each site provides better protection to the feature and its ecological function than the application of buffer zones. As many large blocks of contiguous mid-aged to mature forest around the den site as possible should be protected; even more area (an additional 100 m) may be required if disturbance is likely to be a problem.

For development on lands adjacent to mammal denning SWH, site the development as far as possible from the SWH. As much as possible, minimize the amount of forested habitat that is cleared for the development (including access roads); this option may help reduce the effects of habitat fragmentation.

Eastern Wolf

Potential Development Effects

Eastern wolves are timid and easily disturbed by human activity (Parks Canada 2009). Increased human activity will occur where active aggregate sites are developed. Increased human activity in Eastern Wolf habitat increases the probability of human-wolf conflicts, resulting in wolf mortality through such means as hunting, trapping and vehicle strikes (OMNR 2005a; Environment Canada 2007b; Parks Canada 2009). Many people view wolves as a threat to public safety (OMNR 2005a). In a study of gray wolves inhabiting the Pukaskwa/White River Forest region, 47% of wolf mortality was human-caused (Forshner 2002, in Theberge 2002).

Mammalian carnivores are particularly vulnerable to extinction in fragmented landscapes (Woodroffe and Ginsberg 1998). Species most at risk are the ones that range widely, and are therefore most exposed to threats on reserve borders. Developments that fragment the forest threaten wolf populations by compromising travel corridors and isolating populations from neighbouring wolf range (OMNR 2005a); connectivity with adjacent range is necessary to ensure population persistence. On the other hand, openings in the forest encourage early successional vegetation growth that enhances habitat for the wolf's ungulate prey species (OMNR 1986); however, the net impact for wolves is likely to be negative if there is no protection in these areas against persecution by humans.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes any known Eastern Wolf denning site plus a 200 m radius of undisturbed habitat around it.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in Eastern Wolf denning SWH will destroy the affected habitat, and fragment the habitat as a whole. Habitat fragmentation, and human disturbance associated with the development, will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

The Significant Wildlife Habitat Technical Guide (OMNR 2000) recommends that den sites for eastern wolves, and adjacent habitat, should be protected from development. When a significant wildlife habitat feature is part of a larger natural area, it is difficult to quantify the amount of habitat that needs to be protected. For wolf dens, protecting as much well-connected habitat around each site as possible provides better protection to the feature and its ecological function than the application of buffer zones.

For development on lands adjacent to Eastern Wolf denning SWH, minimize the total amount of forested habitat that is cleared for the development; this may help mitigate the impacts of habitat fragmentation. Timing development activities to occur outside the denning period may be an effective option for mitigating disturbance impacts. For example, forest management guidelines for Ontario prohibit all operations near identified wolf dens during the denning period of April 15 – July 15 in the boreal forest and April 1 – June 30 in the Great Lakes St. Lawrence forest. These restrictions apply to dens known or suspected to have been occupied by eastern wolves at least once within the last 10 years (OMNR 2008a).

Where wolves are afforded some degree of protection and prey remains abundant, they are able to inhabit areas with relatively high human activity (Mech 1993, in Buss and de Almeida 1997; OMNR 2005a). Educating people about the ecology and status of wolves can alleviate negative attitudes and reactions to wolves, and promote understanding and acceptance of wolf conservation programs. For example, wolves are timid and tend to avoid areas of human activity (Parks Canada 2009), so the number of incidents in which wolves threaten public safety is likely small (OMNR 2005a).

ENERGY DEVELOPMENT

Mustelids

Potential Development Effects: Wind Power Facilities

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Clearing forested habitat for wind power development will fragment the habitat. Mammalian carnivores are particularly vulnerable to extinction in fragmented landscapes (Woodroffe and Ginsberg 1998). Species most at risk are the ones that range widely, and are therefore most exposed to threats on reserve borders. Any development that reduces or fragments mature forests will have a negative impact on mustelids.

Fisher avoid recently cleared areas, probably because they lack cover for dens and prey species (de Vos 1952, in Racey and Hessey 1989). Clearcutting within mature coniferous or mixed forest reduces marten densities and increases home range size (Thompson and Colgan 1987) in response to changes in prey species composition and abundance. For example, it typically takes up to 7 years for snowshoe hare to re-colonize cutover habitat, with peak use taking up to 20 years to occur (Litvaitis et al. 1985). Fisher also appear to respond numerically to changes in snowshoe hare abundance (Bowman et al. 2006); reduced hare abundance correlates with reduced fisher abundance.

Clearcutting in spruce-dominated boreal forests also results in marked changes in the small mammal community, with red-backed voles being replaced as the dominant small mammal by species less preferred by marten as prey (OMNR 1996). Marten densities can remain low in clearcut habitats for up to 40 years (Soutiere 1979; Steventon and Major 1982; Snyder and Bissonette 1987), and marten mortality in clearcuts is also "markedly higher" than in uncut forests (Thompson 1994).

Roads that accompany development further fragment the habitat, and increase mortality through vehicle strikes (see about Road Development, below).

Where development is proposed for shoreline habitat, there is a potential for adverse effects from dredging, filling, and clearing of woody debris and other natural shoreline structure. Developments that alter shoreline habitat can have an impact on mink and otter denning habitat. Racey and Euler (1983) found a significant negative correlation between mink density and intensity of development on lakes in central Ontario. Mink dens occurred in areas with higher than average shrub densities, deadfalls, stumps and trees; all of these elements were reduced on developed shorelines by clearing and the introduction of non-native plant species. Shoreline development also simplified the littoral zone by the removal of snags, large boulders, and aquatic vegetation. These changes in vegetation composition and habitat structure had a significant impact on the species composition and abundance of the mink's terrestrial and aquatic prey.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of mammal denning SWH for mustelids should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. The SWH includes any known active denning site plus a 20 m radius of undisturbed habitat around it. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Forest clearing and shoreline alteration within mammal denning SWH will reduce or destroy the ecological function of the habitat. Human disturbance associated with an active development will further reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

The Significant Wildlife Habitat Technical Guide (OMNR 2000) recommends that den sites for marten and fisher, and adjacent forested habitat, should be protected from development. When a significant wildlife habitat feature is part of a larger natural area, it is difficult to quantify the amount of habitat that needs to be protected. For marten and fisher dens, protecting as much well-connected habitat around each site provides better protection to the feature and its ecological function than the application of buffer zones. As many large blocks of contiguous mid-aged to mature forest around the den site as possible should be protected; even more area (an additional 100 m) may be required if disturbance is likely to be a problem.

For development on lands adjacent to mammal denning SWH, site the development as far as possible from the SWH, and minimize the amount of forested habitat that is cleared (including for access roads). These measures may help reduce the effects of habitat fragmentation and depressed prey abundance. Sullivan and Sullivan (2001) found that the abundance of red-backed voles, a preferred food of the American marten, was positively related to the density of residual trees after harvest. Additionally, schedule construction activities to occur when dens are not in use.

Where wind power development is proposed along shoreline habitat adjacent to mammal denning SWH, site the development as far as possible from the SWH. Minimize shoreline alteration at the development by retaining as much of the original shoreline structure as possible (e.g., snags and downed woody debris). High quality aquatic habitats that produce an abundance of fish, crustaceans and insects are a very important component of mammal denning habitat. Natural, undisturbed habitats are best. During construction, implement control measures around the site to prevent sedimentation in the aquatic habitat adjacent to the development.

Potential Development Effects: Solar Power Facilities

Developments that alter shoreline habitat can have an impact on mink and otter denning habitat. Mink dens occurred in areas with higher than average shrub densities, deadfalls, stumps and trees. All of these elements can be reduced by shoreline development, e.g., clearing and shoreline stabilization.

High quality aquatic habitats that produce an abundance of fish, frogs and a variety of aquatic invertebrates are required for otters (OMNR 1986, 2000). Shoreline simplification due to clearing and shoreline stabilization will negatively affect the species composition and abundance of aquatic prey species. Prey abundance may also be depressed by reduced water quality as a result of polluted runoff from onshore development sites. Reduced prey abundance and species richness may in turn reduce the quality of the habitat for denning otters and mink. Additionally, because otters spend much of their time in the water, and find most of their food in the water, they are at risk of being directly harmed by water pollution; otters are not tolerant of polluted ecosystems (NYSDEC 2010a). Toxins taken up by prey species accumulate in the tissues of top predators, causing a variety of health effects. Environmental contaminants are known to cause weight loss and reproductive problems in captive mink, but the impact on wild mink is not known (NYSDEC 2010b).

Mammalian carnivores are particularly vulnerable to extinction in fragmented landscapes (Woodroffe and Ginsberg 1998). Species most at risk are the ones that range widely, and are therefore most exposed to threats on reserve borders. Any development that reduces or fragments mature forests will have a negative impact on mustelids, e.g., installation of solar panel arrays in wooded sites. Fisher avoid recently cleared areas, probably because they lack cover for dens and prey species (de Vos 1952, in Racey and Hessey 1989). Clearcutting within mature coniferous or mixed forest reduces marten densities and increases home range size (Thompson and Colgan 1987) in response to changes in prey species composition and abundance. For example, it typically takes up to 7 years for snowshoe hare to re-colonize cutover habitat, with peak use taking up to 20 years to occur (Litvaitis et al. 1985). Fisher also appear to respond numerically to changes in snowshoe hare abundance (Bowman et al. 2006); reduced hare abundance correlates with reduced fisher abundance. Clearcutting in spruce-dominated boreal forests also results in marked changes in the small mammal community, with red-backed voles being replaced as the dominant small mammal by species less preferred by marten as prey (OMNR 1996). Marten densities can remain low in clearcut habitats for up to 40 years (Soutiere 1979; Steventon and Major 1982; Snyder and Bissonette 1987), and marten mortality in clearcuts is also "markedly higher" than in uncut forests (Thompson 1994).

Development is also associated with increased human activity. In the case of solar power development, human disturbance will occur during construction and operation of the project (e.g., maintenance). Human activity within the vicinity of dens may affect use by some species (OMNR 2008a).

Access roads for the development may increase mortality through vehicle strikes
(see about Road Development, below).

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of mammal denning SWH for mustelids should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The SWH includes any known active denning site plus a 20 m radius of undisturbed habitat around it. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Shoreline alteration and forest clearing within mammal denning SWH will reduce or destroy the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat.

The Significant Wildlife Habitat Technical Guide (OMNR 2000) recommends that den sites for marten and fisher, and adjacent forested habitat, should be protected from development. When a significant wildlife habitat feature is part of a larger natural area, it is difficult to quantify the amount of habitat that needs to be protected. For marten and fisher dens, protecting as much well-connected habitat around each site provides better protection to the feature and its ecological function than the application of buffer zones. As many large blocks of contiguous mid-aged to mature forest around the den site as possible should be protected; even more area (an additional 100 m) may be required if disturbance is likely to be a problem.

For development on lands adjacent to mammal denning SWH, site the development as far as possible from the SWH. Minimize shoreline alteration at the development by retaining as much of the original shoreline structure as possible (e.g., snags and downed woody debris). High quality aquatic habitats that produce an abundance of fish, crustaceans and insects are a very important component of mammal denning habitat. Natural, undisturbed habitats are best. Minimize the amount of forested habitat that is cleared for the development; this option may help reduce the effects of habitat fragmentation for marten and fisher.

Eastern Wolf

Potential Development Effects: Wind Power Facilities

Eastern wolves are timid and easily disturbed by human activity (Parks Canada 2009). Increased human activity will occur where active aggregate sites are developed. Increased human activity in Eastern Wolf habitat increases the probability of human-wolf conflicts, resulting in wolf mortality through such means as hunting, trapping and vehicle strikes (OMNR 2005a; Environment Canada 2007b; Parks Canada 2009). Many people view wolves as a threat to public safety (OMNR 2005a). In a study of gray wolves inhabiting the Pukaskwa/White River Forest region, 47% of wolf mortality was human-caused (Forshner 2002, in Theberge 2002).

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Clearing forested habitat for wind power development will fragment the habitat. Mammalian carnivores are particularly vulnerable to extinction in fragmented landscapes (Woodroffe and Ginsberg 1998). Species most at risk are the ones that range widely, and are therefore most exposed to threats on reserve borders. Developments that fragment the forest threaten wolf populations by compromising travel corridors and isolating populations from neighbouring wolf range (OMNR 2005a); connectivity with adjacent range is necessary to ensure population persistence. On the other hand, openings in the forest encourage early successional vegetation growth that enhances habitat for the wolf's ungulate prey species (OMNR 1986); however, the net impact for wolves is likely to be negative if there is no protection in these areas against persecution by humans.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of mammal denning SWH for eastern wolves should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The SWH includes any known Eastern Wolf denning site plus a 200 m radius of undisturbed habitat around it. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in Eastern Wolf denning SWH will destroy the affected habitat, and fragment the habitat as a whole. Habitat fragmentation, and human disturbance associated with the development, will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

The Significant Wildlife Habitat Technical Guide (OMNR 2000) recommends that den sites for eastern wolves, and adjacent habitat, should be protected from development. When a significant wildlife habitat feature is part of a larger natural area, it is difficult to quantify the amount of habitat that needs to be protected. For wolf dens, protecting as much well-connected habitat around each site as possible provides better protection to the feature and its ecological function than the application of buffer zones.

For development on lands adjacent to Eastern Wolf denning SWH, minimize the total amount of forested habitat that is cleared for the development; this may help mitigate the impacts of habitat fragmentation. Timing development activities to occur outside the denning period may be an effective option for mitigating disturbance impacts. For example, forest management guidelines for Ontario prohibit all operations near identified wolf dens during the denning period of April 15 – July 15 in the boreal forest and April 1 – June 30 in the Great Lakes St. Lawrence forest. These restrictions apply to dens known or suspected to have been occupied by eastern wolves at least once within the last 10 years (OMNR 2008a).

Where wolves are afforded some degree of protection and prey remains abundant, they are able to inhabit areas with relatively high human activity (Mech 1993, in Buss and de Almeida 1997; OMNR 2005a). Educating people about the ecology and status of wolves can alleviate negative attitudes and reactions to wolves, and promote understanding and acceptance of wolf conservation programs. For example, wolves are timid and tend to avoid areas of human activity (Parks Canada 2009), so the number of incidents in which wolves threaten public safety is likely small (OMNR 2005a).

Potential Development Effects: Solar Power Facilities

Eastern wolves are timid and easily disturbed by human activity (Parks Canada 2009). Development brings increased human activity. In the case of solar power development, human disturbance will occur during construction and operation of the project (e.g., maintenance). Increased human activity in Eastern Wolf habitat increases the probability of human-wolf conflicts, resulting in wolf mortality through such means as hunting, trapping and vehicle strikes (OMNR 2005a; Environment Canada 2007b; Parks Canada 2009). In a study of gray wolves inhabiting the Pukaskwa/White River Forest region, 47% of wolf mortality was human-caused (Forshner 2002, in Theberge 2002). Regular human activity at a project site may also cause avoidance behaviour in wolves (Parks Canada 2009), resulting in the loss of usable habitat.

Mammalian carnivores are particularly vulnerable to extinction in fragmented landscapes (Woodroffe and Ginsberg 1998). Species most at risk are the ones that range widely, and are therefore most exposed to threats on reserve borders. Any development that reduces or fragments mature forests, e.g., clearing for the installation of solar panel arrays in wooded sites, threatens wolf populations by compromising travel corridors and isolating populations from neighbouring wolf range (OMNR 2005a); connectivity with adjacent range is necessary to ensure population persistence. On the other hand, openings in the forest encourage early successional vegetation growth that enhances habitat for the wolf's ungulate prey species (OMNR 1986); however, the net impact for wolves is likely to be negative if there is no protection in these areas against persecution by humans.

Losses of wolf habitat in Ontario to agriculture, logging and urban expansion are ongoing (Parks Canada 2009).

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of mammal denning SWH for eastern wolves should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The SWH includes any known Eastern Wolf denning site plus a 200 m radius of undisturbed habitat around it. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in Eastern Wolf denning SWH will destroy the affected habitat, and fragment the habitat as a whole. Habitat fragmentation, and human disturbance associated with the development, will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

The Significant Wildlife Habitat Technical Guide (OMNR 2000) recommends that den sites for eastern wolves, and adjacent habitat, should be protected from development. When a significant wildlife habitat feature is part of a larger natural area, it is difficult to quantify the amount of habitat that needs to be protected. For wolf dens, protecting as much well-connected habitat around each site as possible provides better protection to the feature and its ecological function than the application of buffer zones.

For development on lands adjacent to Eastern Wolf denning SWH, minimize the total amount of forested habitat that is cleared for the development; this may help mitigate the impacts of habitat fragmentation.

Timing development activities to occur outside the denning period may be an effective option for mitigating disturbance impacts. For example, forest management guidelines for Ontario prohibit all operations near identified wolf dens during the denning period of April 15 – July 15 in the boreal forest and April 1 – June 30 in the Great Lakes St. Lawrence forest. These restrictions apply to dens known or suspected to have been occupied by eastern wolves at least once within the last 10 years (OMNR 2008a).

Schedule construction and, where possible, regular maintenance activities to occur when wolves are not using the habitat.

Where wolves are afforded some degree of protection and prey remains abundant, they are able to inhabit areas with relatively high human activity (Mech 1993, in Buss and de Almeida 1997; OMNR 2005a). Educating workers about the ecology and status of wolves can alleviate negative attitudes and reactions to wolves, and promote understanding and acceptance of wolf conservation programs. For example, wolves are timid and tend to avoid areas of human activity (Parks Canada 2009), so the number of incidents in which wolves threaten public safety is likely small (OMNR 2005a).

ROAD DEVELOPMENT

Mustelids

Potential Development Effects

All of the development types covered in this index involve the construction and long-term use of roads. Roads fragment habitat by creating a barrier to movement between adjacent patches, particularly for species that avoid roads and have resource needs that require them to travel over large areas (Forman et al. 2003). As road densities increase across the landscape, wildlife habitat is lost and what remains becomes increasingly degraded and fragmented. Any development that reduces or fragments mature forest habitat will have a negative impact on mustelids. As populations become increasingly fragmented, the probability of local extinctions rises, especially if dispersal is hindered (Forman et al. 2003). Mammalian carnivores are particularly vulnerable to extinction in fragmented landscapes (Woodroffe and Ginsberg 1998). Species most at risk are the ones that range widely, and are therefore most exposed to threats on reserve borders.

Road effects can also be cumulative. For example, a service road along a pipeline or power corridor may be a more formidable barrier (i.e., be less "permeable") to wildlife than if it was not adjacent to another linear disturbance (Blanco and Cortes 2001; Forman et al. 2003). The biological effects of habitat fragmentation range from declines in species that require large, contiguous habitat patches to increasing dispersal of non-native species (Hilty and Merenlender 2004). Road development also results in habitat loss and reduced habitat quality. When habitat is lost and/or degraded due to conversion into roadway, declines in population size can be expected (Forman et al. 2003). On the other hand, roads can also provide travel corridors for predators that improve access to prey (Ambuel and Temple 1983; Forman et al. 2003; Weldon 2006).

Roads also threaten wildlife populations directly, by way of mortality due to vehicle strikes. Where mortality levels are high, population-level impacts will likely be detectable within 1 or 2 generations (Forman et al. 2003).

Roads into mustelid range increase human access to furbearers, which has the potential to increase trapping pressure by reducing the unexploited portions of traplines (Thompson 1988). Increased access to formerly roadless areas could greatly impact mustelid populations in areas where harvest pressure is already high.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes any known active denning site plus a 20 m radius of undisturbed habitat around it.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in mammal denning SWH will destroy the affected habitat, and fragment the habitat as a whole. Habitat fragmentation, and human disturbance associated with the development, will reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

There are 3 steps in the process of ecologically sensitive road planning; these are avoidance, mitigation, and compensation (Forman et al. 2003). The best way to alleviate habitat degradation/loss and mortality associated with road construction and use is to avoid making an impact by not building the road (Forman et al. 2003). In Ontario, the guideline for forest access roads prohibits construction within 20 m of a furbearer den entrance (OMNR 2008a). Where avoidance is not possible, impacts can be mitigated by incorporating travel corridors (e.g., underpasses) into the road design to facilitate wildlife movement between habitat patches adjacent to the road, thereby reducing both road-related mortality and the fragmentation effect (Blanco and Cortes 2001; Forman et al. 2003). For example, an underpass in Vermont that has proven effective for mink passage consists of a concrete culvert that measures 98 m long, 3 m wide and 4 m high (Austin and Garland 2001). The culvert is divided into 2 tunnels, one of which contains a stream and the other facilitates animal passage under the highway. The substrate of both tunnels consists of large, coarse rock with mud and sand in the interstices, which seems to provide good movement cover for small mammals, but likely restricts the movements of ungulates. Additionally, human activity at crossing sites must be minimized in order to maximize use by wildlife (Smith 2003).

Otters and marten have also been reported to use underpasses. In Florida, otters use a box culvert under a highway that runs through wet prairie habitat. An underpass monitoring study in Florida found that aquatic mammals, including otters, most often use culverts that are at least 1 m wide by 0.9 m high, and no more than 15 m long (Smith 2003). This same study recommends that right-of-way vegetation near crossing sites be the same as that in adjacent habitat, with slightly great cover near culvert entrances. Clevenger and Waltho (1999) reported that martens frequently use drainage culverts to cross under the TransCanada Highway in Banff National Park. They recommend that culverts be placed at frequent intervals (150-300 m) to provide sufficient opportunities for crossing under rather than over the road surface. Additional measures for mitigating the negative impacts of roads on mustelids could include removing selected roads to reconnect fragmented habitat (Criley 2000). For otters, removing roads that cross or are adjacent to watercourses is most effective; for marten, removal of roads that expand trapping into previously untrapped areas is recommended. These measures would serve to decrease road-related mortality for mustelids and increase the amount of habitat free of human development (Criley 2000).

A comprehensive evaluation of wildlife underpasses and overpasses is given in Forman et al. (2003:147).

Additionally, stormwater best management practices should always be used to minimize the dispersal of road-related pollutants (Forman et al. 2003). Where roads cross streams, erosion and flooding effects should be minimized (OMNR 1986).

Fishers have recently recovered from historic extirpations across much of their historic range (Lancaster et al. 2008). There are several likely explanations for this change, including reduced trapping pressure and an increase in forested habitat over the past 50 years as a result of land conversion from agricultural uses (Lancaster et al. 2008). Increased fisher abundance has occurred despite an increase in road density that has created smaller roadless habitat patches (Lancaster et al. 2006), suggesting that the negative impacts of habitat fragmentation on this species can be mitigated by increased total habitat area and reduced anthropogenic mortality. Where possible, replacement of lost habitat with a greater quantity of better quality habitat (i.e., compensation) should be considered. Compensation typically involves improvement of habitat close to the impact location, but not within the zone of road effects or where future road effects are likely to occur (Forman et al. 2003). For example, add structure to adjacent forested habitat to enhance its value as mustelid denning habitat, and/or to enhance its value as habitat for mustelid prey species.

Eastern Wolf

Potential Development Effects

All of the development types covered in this index involve the construction and long-term use of roads. Roads fragment habitat by creating a barrier to movement between adjacent patches, particularly for species that avoid roads and have resource needs that require them to travel over large areas (Forman et al. 2003). Although roads do not present an absolute barrier to wolf movement, they do alter how wolves move across their territories; travel routes tend to be more tortuous in areas of higher road density (Wittington et al. 2004).

Roads also constitute an additional mortality factor for wolves. Road-related mortality can be high, and affect an entire population (Kohn et al. 2009). Additionally, increased mortality and barriers to movement combine to effectively reduce the suitability of the habitat (Kohn et al. 2009). In a Wisconsin study, wolves were intolerant of roads and human disturbance near dens; they selected den sites within their core range where road densities were low relative to densities elsewhere in the core (Kohn et al. 2000). On the whole, wolves tend to avoid areas of high road density (Wittington et al. 2005). As road densities increase across the landscape, wildlife habitat is lost and what remains becomes increasingly degraded and fragmented. Any development that reduces or fragments mature forest habitat will have a negative impact on eastern wolves. As populations become increasingly fragmented, the probability of local extinctions rises, especially if dispersal is hindered (Forman et al. 2003). Mammalian carnivores are particularly vulnerable to extinction in fragmented landscapes (Woodroffe and Ginsberg 1998). Species most at risk are the ones that range widely, and are therefore most exposed to threats on reserve borders.

Increasing road densities also lead to more contacts between humans and wolves, more human exploitation of wolves, more mortality due to vehicle strikes, and the threat of local wolf population extirpation (Sears 1999, in Theberge 2002; OMNR 2005a; Environment Canada 2007b). In a Wisconsin study, Thiel (1985) found that wolf status changed from breeding to nonbreeding or absent when road densities reached 0.59 – 0.66 km/km2, concluding that a direct relationship existed between road density and wolf vulnerability to overexploitation. Mech et al. (1988) reported a slightly more conservative lower threshold of 0.54 km/km2 for Minnesota, above which wolf range was described as "peripheral", "disjunct" or uninhabited. Wolf populations near Sault Ste. Marie, Ontario, could not sustain themselves at road densities of 0.6 km/km2 or greater (Jenson et al. 1986). Roads also threaten wildlife populations directly, by way of mortality due to vehicle strikes. Where mortality levels are high, population-level impacts will likely be detectable within 1 or 2 generations (Forman et al. 2003).

On the other hand, wolves have been reported to use roads with little human activity as travel corridors; as such, roads may increase wolf access to prey (OMNR 1986; Forman et al. 2003). It is likely, however, that the net impact of roads on wolves is negative if there is no protection in these areas against persecution by humans.

Wolves are not habitat specialists; their presence on the landscape is driven mostly by the habitat needs of their prey and the degree of wolf harvest by humans (OMNR 2005a). The primary prey species of wolves in Ontario are moose, deer, caribou and beaver. Moose and deer are the primary ungulate species sought by hunters, and beaver is the most common furbearer trapped throughout Ontario's wolf range. Human access to wolf range through road development increases wolf-human competition for these resources (OMNR 2005a, which puts wolves at further risk of mortality at the hands of humans.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The SWH includes any known Eastern Wolf denning site plus a 200 m radius of undisturbed habitat around it.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Forest clearing within mammal denning SWH will fragment the habitat and reduce or destroy its ecological function. Human disturbance associated with an active aggregate site will further reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat.

There are 3 steps in the process of ecologically sensitive road planning; these are avoidance, mitigation and compensation (Forman et al. 2003). The best way to alleviate habitat degradation/loss and mortality associated with road construction and use is to avoid making an impact by not building the road (Forman et al. 2003). In Ontario, the guideline for forest access roads discourages construction within 200 m of a wolf den entrance (OMNR 2008a). This guideline applies to dens known or suspected to have been occupied by eastern wolves at least once within the last 10 years. Where avoidance is not possible, impacts can be mitigated by incorporating travel corridors (e.g., underpasses) into the road design to facilitate wildlife movement between habitat patches adjacent to the road, thereby reducing both road-related mortality and the fragmentation effect (Blanco and Cortes 2001; Forman et al. 2003). Human activity at crossing sites must be minimized in order to maximize use by wildlife (Smith 2003); wolves avoid culverts in areas of human activity (Clevenger and Waltho 2000). A particularly effective underpass has been designed for the 4-lane Trans-Canada Highway in Banff National Park, Alberta. This underpass is 11 m wide, 3 m high and has good sight lines to vegetation on the far side (Forman et al. 2003). Wolves, bears and cougars commonly use this passageway to cross under the highway.

To ensure wolf population persistence, road densities of less than 0.54 – 0.59 km/km2 have been recommended (Thiel 1985; Mech et al. 1988) in areas where wolves are legally protected from human persecution and populations are stable or increasing (Theberge 2002). Where wolves are not protected, and/or populations are declining, planners should aim for densities much lower than this (Sears 1999, in Theberge 2002).

Where wolves are afforded some degree of protection and prey remains abundant, they are able to inhabit areas with relatively high human activity (Mech 1993, in Buss and de Almeida 1997; OMNR 2005a). Educating people about the ecology and status of wolves can alleviate negative attitudes and reactions to wolves, and promote understanding and acceptance of wolf conservation programs. For example, wolves are timid and tend to avoid areas of human activity (Parks Canada 2009), so the number of incidents in which wolves threaten public safety is likely small (OMNR 2005a). Additionally, wolves pose a smaller threat to livestock and pets than many people believe. Most reports of domestic animal depredation can actually be attributed to coyotes rather than to wolves (OMNR 2005a). A number of Provincial Parks currently use the wolf as a subject in their interpretive programs; the most consistent and notable interpretive programs are those of Algonquin Provincial Park (OMNR 2005a).

It is not only road density within wolf range but also the level of non-vehicular human use (e.g., biking, walking, horse-back riding) associated with those roads that affects range use by wolves (Mech et al. 1988). Where possible, restricting non-vehicular human use of roads may also help mitigate against the negative impacts of roads on local wolf populations. This mitigation was recommended by Theberge (2002) in response to a proposal to construct a new road along the northern boundary of Pukaskwa National Park, where it would intersect the territories of 4 different gray wolf packs.

HABITAT OF
SPECIES OF CONSERVATION CONCERN

INDEX #32: OPEN COUNTRY BIRD BREEDING HABITAT

Ecoregions:	All of Ontario
Species Group:	Open Country Bird Species: Grasshopper Sparrow, Vesper Sparrow, Savannah Sparrow, Upland Sandpiper, Western Meadowlark, Horned Lark, Prairie Warbler, Northern Harrier, American Kestrel, Short-eared Owl (SPECIAL CONCERN), Le Conte's Sparrow (SPECIAL CONCERN)
Significant Wildlife Habitat Category:	Habitat of Species of Conservation Concern
Functional Habitat:	Breeding Habitat
Habitat Features:	Large Grasslands that are not being actively farmed The Bobolink (THREATENED), the Eastern Meadowlark (THREATHENED), the Northern Bobwhite (ENDANGERED), the Loggerhead Shrike (ENDANGERED) and Henslow's Sparrow (ENDANGERED) are protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that may affect these species.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

A number of Ontario's birds require areas of relatively large open grasslands for breeding. Other species nesting in these habitats may not require extensive areas, but have very specific habitat requirements which limit their distribution. For these species, grassland areas provide essential food, cover and nesting habitat. A subset of these species also nests colonially in grassland, prairie, alvar, and savannah habitats. Colonially-nesting birds tend to nest close together, leaving much of the apparently suitable habitat unused. Colonial birds are highly susceptible to the effects of development, as impacts on a colony may affect regional populations.

See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

Grassland species are at high risk because the habitat on which they depend is generally considered wasteland with limited ecological value. These habitats are often considered prime development areas, and they are frequently planted to trees. Most of these species are experiencing declines. Many other grassland birds, not included in this index because they are relatively common in Ontario, also have declining populations.

Development which affects habitat supporting any of these bird species will affect the use of this significant wildlife habitat. Other species in this guild are considered special concern in the province, and the guidelines for the PPS suggest that, at a minimum, the best examples of habitat for special concern species should always be maintained.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Residential or commercial development which reduces the amount of suitable habitat will affect the number of birds which can use the field for breeding. Most birds are territorial during the nesting season and must retain a large enough area to forage and provide for their offspring. Reductions in the area of field will result in the loss of nesting territories or a reduction in the amount of food available to birds. The net result is a reduction in brood success. Loss of suitable habitat is particularly critical to area-sensitive species that require a large patch of suitable habitat. Decreasing the amount of grassland habitat below a species' threshold size may result in its abandoning the area. For example, reducing the area of grassland from 150 ha to 50 ha will reduce the number of breeding pairs of species that are not particularly area sensitive, but may result in the loss of breeding Short-eared Owls. Even loss of suitable habitat that is not directly inhabited may affect certain species such as the Sharp-tailed Grouse.

Jones and Bock (2002) examined the effects of urbanization on grassland birds in Boulder, Colorado. The city and county there maintain a large grassland open-space system that is imbedded within an area of rapid urban growth. They conducted bird counts and compared populations present in the 1980s and 1990s to those present between 1900 and 1937. They found that species typically associated with shortgrass prairie disappeared or declined significantly, but that those that were associated with mixed and tallgrass habitats increased or held steady. Declining species included Common Nighthawk and Loggerhead Shrike, while species that held their own were Vesper Sparrow, Savannah Sparrow, Grasshopper Sparrow, Bobolink, and Western Meadowlark. It should be noted, however, that 50% of the area was still in grasslands and hayfields.

Site alterations which change the composition or structure of grasslands (i.e., establishing lawns, etc.) or which result in the conversion of open areas to forest (i.e., tree planting or prevention of fire or grazing which once kept the area open) will have negative impacts on grassland birds. Many of these species have very specific microhabitat requirements (see the Appendix of species descriptions); any changes in these will be detrimental.

Northern Harriers are known to leave suitable nesting habitat because of heavy use by humans. There are also records of birds abandoning newly laid eggs in response to human interference (Macwhirter and Bildstein 1996). Human incursion into the nesting habitat may also lead predators to nests.

Many of the species in this group nest on the ground and have very specific soil moisture requirements. Development which results in fields becoming drier or wetter may result in abandonment of the area by the species of concern.

Residential developments which result in there being many free-ranging pets (cats and dogs) will affect nest success by introducing significant predation to the area. Domestic cats are significant competitors for prey for species such as Northern Harrier and Short-eared Owl and direct predators of nests of species within this guild.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of SWH is the contiguous ELC ecosite field areas.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing grassland habitat for development will result in its loss under the footprint of the development, and reduced ecological function in the remaining grassland due to fragmentation and succession. Human disturbance associated with the development will further reduce the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected.

The area left needs to be in one large patch rather than split up or fragmented. Patch shape is also important, much the same as for interior forest. Clustering development may reduce the amount of habitat that is affected. If development must occur in the grassland habitat, it should always be directed toward the edge of the habitat instead of centrally.

Development activities occurring adjacent to large areas of grassland habitat should always consider sensitive periods of various species of concern. For example, noisy disturbances such as excavation or blasting should never be scheduled around periods when birds are nesting or raising fledglings.

Impact Assessments will address drainage, habitat structure, and human and pet usage. Stormwater management studies and, in some cases, hydro-geological studies, will be required to determine if changes in grassland moisture regimes will occur. If changes may occur, then impacts on vegetation composition and structure need to be determined along with ramifications on grassland species (e.g., loss of cover, forage material). Species that require tall, thick grasses such as the Henslow's Sparrow are especially vulnerable to a site becoming drier.

Even if drainage patterns and most of the grassland are maintained, management (or lack of intervention) may be required. Landowners may consider an adjacent old field to be a weedy eyesore. The temptation to plant trees or mowing must be averted, as must the desire to cut dead trees and branches or remove snags (TNC 2000). Interpretational signs or other educational techniques should be employed so that residents understand that they are living adjacent to significant wildlife habitat and species. However, the reality is that interpretation often does not work.

Many grassland areas need active management to prevent them becoming overgrown with shrubs and trees. Significant grassland areas that are set aside from development should be turned over to a public agency such as a conservation authority so that agency can undertake the management required to maintain habitat that is suitable for open-country breeding birds.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses are the only types of major recreational development that are likely to affect grassland birds.

Recreational development which reduces the amount of suitable habitat will affect the number of birds which can use the field for breeding. Most birds are territorial during the nesting season and must retain a large enough area to forage and provide for their offspring. Reductions in the area of field will result in the loss of nesting territories or a reduction in the amount of food available to birds. The net result is a reduction in brood success. Loss of suitable habitat is particularly critical to area-sensitive species that require a large patch of suitable habitat. Decreasing the amount of grassland habitat below a species' threshold size may result in its abandoning the area. For example, reducing the area of grassland from 150 ha to 50 ha will reduce the number of breeding pairs of species that are not particularly area sensitive, but may result in the loss of breeding Short-eared Owls. Even loss of suitable habitat that is not directly inhabited may affect certain species such as the Sharp-tailed Grouse.

Site alterations which change the composition or structure of grasslands (i.e., establishing lawns, etc.) or which result in the conversion of open areas to forest (i.e., tree planting or prevention of fire or grazing which once kept the area open) will have negative impacts on grassland birds. Many of these species have very specific microhabitat requirements (see the Appendix of species descriptions); any changes in these will be detrimental.

Northern Harriers are known to leave suitable nesting habitat because of heavy use by humans. There are also records of birds abandoning newly laid eggs in response to human interference (Macwhirter and Bildstein 1996). Human incursion into the nesting habitat may also lead predators to nests.

Many of the species in this group nest on the ground and have very specific soil moisture requirements. Development which results in fields becoming drier or wetter may result in abandonment of the area by the species of concern.

Recreational developments which result in increased numbers of free-ranging dogs will affect nest success by introducing significant predation to the area.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of SWH is the contiguous ELC ecosite field areas.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing grassland habitat for development will result in its loss under the footprint of the development, and reduced ecological function in the remaining grassland due to fragmentation and succession. Human disturbance associated with the development will further reduce the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected.

As much natural grassland habitat as possible should always be maintained on golf courses in areas where active play will not occur. LeClerc and Cristol (2005) examined avian communities on golf courses and found that they generally supported few species of conservation concern as defined by Partners in Flight. The authors concluded that golf course designers could increase the conservation value of courses by increasing the amount of forested land on the course. This would probably be true of grassland habitat.

The area left needs to be in one large patch rather than split up or fragmented. Patch shape is also important, much the same as for interior forest. Clustering development may reduce the amount of habitat that is affected. If development must occur in the grassland habitat, it should always be directed toward the edge of the habitat instead of centrally.

Impact Assessments will address drainage, habitat structure, and human and pet usage. Stormwater management studies and, in some cases, hydro-geological studies, will be required to determine if changes in grassland moisture regimes will occur. If changes may occur, then impacts on vegetation composition and structure should be determined along with ramifications on significant grassland species (e.g., loss of cover, forage material). Species that require tall, thick grasses such as the Henslow's Sparrow are especially vulnerable to a site becoming drier.

Many grassland areas need active management to prevent them becoming overgrown with shrubs and trees. Significant grassland areas that are set aside from development should be turned over to a public agency such as a conservation authority so that agency can undertake the management required to maintain habitat that is suitable for open-country breeding birds.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Grassland-nesting birds are most likely to be affected by sand and gravel pits and stone quarries.

Excavation within grassland habitat will result in a direct loss of habitat. Depending upon whether excavation occurs below the water table and what the end rehabilitation of the pit or quarry is, the loss may be permanent or temporary. Where excavation occurs below the water table, the end rehabilitation will probably be to a lake or wetland and loss of grassland habitat will be permanent. If all extraction takes place above the water table, there may be opportunities to rehabilitate the site to grassland once the aggregate resource is depleted.

The moisture regime of grasslands may be altered by pits and quarries. This may occur when the pit or quarry is within the surface watershed of the grassland, if groundwater flow to the grassland is interrupted, or if water from dewatering activities is directed toward the wetland.

Dust from operations may affect the vegetation communities and the habitat for grassland birds.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of SWH is the contiguous ELC ecosite field areas.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing grassland habitat for development will result in its loss under the footprint of the development, and reduced ecological function in the remaining grassland due to fragmentation and succession. Human disturbance associated with the development will further reduce the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected.

The area left needs to be in one large patch rather than split up or fragmented. Patch shape is also important, much the same as for interior forest. Clustering development may reduce the amount of habitat that is affected. If development must occur in the grassland habitat, it should always be directed toward the edge of the habitat instead of centrally.

Development activities occurring adjacent to large areas of grassland habitat should always consider sensitive periods of various species of concern. For example, noisy disturbances such as excavation or blasting should never be scheduled around periods when birds are nesting or raising fledglings.

Hydrological and hydro-geological studies should be undertaken to determine if the pit or quarry will change the moisture regime of the grassland. If changes are likely to occur, the Impact Assessment (or Level 2 Natural Environment Report under the Aggregate Resources Act) should determine if these moisture changes will be detrimental to significant species nesting within the grassland area.

If changes in moisture regime are predicted to have adverse impacts on the grassland habitat, mitigation measures may include pumping water, installing low permeable barriers around the pit or quarry, or directing water from dewatering activities elsewhere.

For sand and gravel pits where extraction occurred above the water table, rehabilitation of the pit should be to grassland. Rehabilitation has an advantage in that the depths of soil over the more sterile subsoils can be managed so that grasslands that are established in the pit are not invaded by shrubs and trees. Soils depths within the pit can be varied to provide different ultimate habitats. Native grass species should always be used as the cover in the rehabilitated pit. The habitat requirements of bird species that nest adjacent to the site and that formerly nested in the location of the pit should always be considered when designing the grassland habitat in the rehabilitated pit. In Ohio and Pennsylvania, the most important habitat for Henslow's Sparrow and Upland Sandpiper is on reclaimed mine spoil.

For small quarries, rehabilitation to grassland may be less feasible due to the steep walls that are typical of quarries; even once typical rehabilitation has been undertaken. For large quarries, grassland restoration is a viable alternative and can be implemented the same as for sand and gravel pits. In quarries, the soil depth can be even better controlled than in rehabilitated pits, as all soils will have to be imported.

Dust suppression should be implemented within active pits and quarries to eliminate dust effects on vegetation.

ENERGY DEVELOPMENT

Potential Development Effects: Biofuel Farms

The ploughing and subsequent conversion of grassland habitat to farmland for the production of crops for ethanol (e.g., biomass feedstock such as corn and soy) will destroy open country breeding bird habitat. Many bird species will avoid monocultures, and those birds that continue to use such areas may have their nests destroyed during ploughing or harvesting of crops.

Mitigation Options: Biofuel Farms

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of SWH is the contiguous ELC ecosite field areas.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on grassland habitat will result in loss of the affected habitat. The best mitigation is to avoid developing biofuel farms in grassland habitat.

Where complete avoidance is not possible, consider cultivating Switchgrass rather than corn or soy for biofuel production. Switchgrass is a native, perennial warm season grass in Ontario (Tallgrass Ontario 2004). Cultivating Switchgrass may benefit grassland nesting birds because it is harvested after the nesting period; its use may actually serve to increase nesting habitat for grassland birds (Samson 1991).

Potential Development Effects: Wind Power Facilities

The primary effect of wind power development on open country breeding bird habitat is habitat loss where pads for turbines and access roads are constructed, and the potential for habitat fragmentation.

There is also the potential that birds will be struck by the turbine blades or will avoid the general area of the wind farm, thus resulting in a behavioural loss of breeding habitat. Bird species that have aerial flight displays may be more at risk of being struck, such as Northern Harrier, Short-eared Owl, Horned Lark, and Bobolink.

Although monitoring data from Ontario wind power facilities are still relatively scarce, more information is being collected all the time. Available information indicates that bird strikes of breeding birds in grassland and agricultural habitats are relatively rare and unlikely to be a limiting factor to most grassland species. Post-construction monitoring at some Ontario wind power facilities has demonstrated minimal to no mortality of Horned Larks and Bobolinks during the nesting season. Limited to no information is yet available on Northern Harrier or Short-eared Owl.

James (2003, 2008) found no aversion of grassland bird species to turbines. Many species nested in close proximity to the turbines or foraged near them, including the Horned Lark and Vesper Sparrow.

Currently, there are limited data on the effects of wind power facilities on breeding birds, with most work focused on migrating birds. In Minnesota, Osborn et al. (2000) studied bird mortality for a full-year period and determined that an average of 1 bird per turbine was killed annually. The wind farm was situated in an agricultural setting with some grassy areas and isolated woodlands. The authors concluded that bird mortality in a grassland/cropland landscape was low and that wind turbines do not appear to kill more birds than other human-made structures.

Drewitt and Langston (2006) stated that the effects of turbines on displacement of breeding birds are largely inconclusive or suggest low-disturbance distances. Most work has been done on long-lived birds with high site-fidelity and therefore the true impacts on these species may only be evident over a long period of time. Few studies have focused on short-living passerines such as the studies by James (2003, 2008).

In the United Kingdom, Devereux et al. (2008) found that wind turbines had minimal effects on the distribution of wintering farmland birds.

From the available information, it does not appear that wind power facilities result in significant mortality of breeding birds or cause a significant avoidance reaction. This, however, needs more study and may be species-specific in some cases.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the edge of open country bird breeding SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. The area of SWH is the contiguous ELC ecosite field areas. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing grassland habitat for development will result in its loss under the footprint of the development, and reduced ecological function in the remaining grassland due to fragmentation. Human disturbance associated with the development (e.g., construction and regular maintenance activities; use of access roads) will further reduce the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected.

Development activities occurring adjacent to large areas of grassland habitat should always consider sensitive periods of various species of concern. For example, noisy disturbances such as excavation or blasting should never be scheduled around periods when birds are nesting or raising fledglings.

Potential Development Effects: Solar Power Facilities

Any development that reduces the amount of suitable habitat will affect the number of birds which can use the field for breeding. Most birds are territorial during the nesting season and must retain a large enough area to forage and provide for their offspring. Reductions in the area of field will result in the loss of nesting territories or a reduction in the amount of food available to birds. The net result is a reduction in brood success. By design, solar panels capture sunlight that would normally reach the habitat. A dramatic reduction in sunlight will have significant impacts on the underlying plant community, likely leading to the loss of vegetation biomass and structure.

Loss of suitable habitat is particularly critical to area-sensitive species that require a large patch of suitable habitat. Decreasing the amount of grassland habitat below a species' threshold size may result in its abandoning the area. For example, reducing the area of grassland from 150 ha to 50 ha will reduce the number of breeding pairs of species that are not particularly area sensitive, but may result in the loss of breeding Short-eared Owls. Even loss of suitable habitat that is not directly inhabited may affect certain species such as the Sharp-tailed Grouse.

Site alterations which change the composition or structure of grasslands will have negative impacts on grassland birds. Many of these species have very specific microhabitat requirements (see the Appendix of species descriptions); any changes in these will be detrimental.

Northern Harriers are known to leave suitable nesting habitat because of heavy use by humans. There are also records of birds abandoning newly laid eggs in response to human interference (Macwhirter and Bildstein 1996).

Many of the species in this group nest on the ground and have very specific soil moisture requirements. Development which results in fields becoming drier or wetter may result in abandonment of the area by the species of concern.

A solar power development adjacent to open country bird breeding SWH is unlikely to affect the neighbouring habitat, unless it changes the habitat's hydrologic regime.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of the edge of open country bird breeding SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The area of SWH is the contiguous ELC ecosite field areas. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing grassland habitat for development will result in its loss under the footprint of the development, and reduced ecological function in the remaining grassland due to fragmentation and succession. Human disturbance associated with the development (e.g., construction and operational maintenance) will further reduce the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected.

The area left needs to be in one large patch rather than split up or fragmented. Patch shape is also important, much the same as for interior forest. Clustering development may reduce the amount of habitat that is affected. If development must occur in the grassland habitat, it should always be directed toward the edge of the habitat instead of centrally.

Development activities occurring adjacent to large areas of grassland habitat should always consider sensitive periods of various species of concern. For example, noisy disturbances such as tree felling, grading, excavation and drilling should never be scheduled around periods when birds are nesting or raising fledglings.

Impact Assessments will address drainage, habitat structure, and human usage. Stormwater management studies and, in some cases, hydro-geological studies, will be required to determine if changes in grassland moisture regimes will occur. If changes may occur, then impacts on vegetation composition and structure need to be determined along with ramifications on grassland species (e.g., loss of cover, forage material). Species that require tall, thick grasses such as the Henslow's Sparrow are especially vulnerable to a site becoming drier.

Many grassland areas need active management to prevent them becoming overgrown with shrubs and trees. Significant grassland areas that are set aside from development should be turned over to a public agency such as a conservation authority so that agency can undertake the management required to maintain habitat that is suitable for open-country breeding birds.

ROAD DEVELOPMENT

Potential Development Effects

The footprint of a road will result in direct habitat loss for grassland-nesting birds.

Roads have the potential to fragment the remaining grassland habitat and make the resulting patches too small to support certain area-sensitive species. This may be more of a problem for passerine species that are area sensitive; passerines are less likely to incorporate habitat on both sides of the road into their home range, as may be done by certain raptor species.

Compounds containing salt are typically used to de-ice roads in winter. Airborne salt spray can travel considerable distances depending upon wind velocity and the speed at which vehicles are traveling. Direct contact with salt spray can kill some vegetation species, and build-up of salt concentrations within surface and ground water over time may affect a wide variety of other species. Roadsides may also become dominated by halophytic plant species, most of which are non-native.

Certain of the bird species may be vulnerable to road kill. The Loggerhead Shrike is particularly sensitive to being struck by vehicles due to its low, undulating flight.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of SWH is the contiguous ELC grassland ecosite.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing grassland habitat for development will result in its loss under the footprint of the development, and reduced ecological function in the remaining grassland due to fragmentation and succession. Human disturbance associated with the development (e.g., noise and motion from passing vehicles, and disturbance from pedestrian traffic) will further reduce the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected.

The area left needs to be in one large patch rather than split up or fragmented. Patch shape is also important, much the same as for interior forest. If development must occur in the grassland habitat, it should always be directed toward the edge of the habitat instead of centrally.

Development activities occurring adjacent to large areas of grassland habitat should always consider sensitive periods of various species of concern. For example, noisy disturbances such as excavation or blasting should never be scheduled around periods when birds are nesting or raising fledglings.

Consideration should be given to using de-icing compounds other than salt through grassland habitat. No herbicides should be used along the roadside to control vegetation.

Road mortality may be mitigated in part by reducing speed limits.

INDEX #33: SHRUB/EARLY SUCCESSIONAL BIRD BREEDING HABITAT

Ecoregions:	All of Ontario
Species Group:	Shrub/Early Successional Bird Species: Yellow-bellied Cuckoo, Eastern Screech Owl, Northern Hawk Owl, Philadelphia Vireo, Carolina Wren, House Wren, Northern Mockingbird, Brown Thrasher, Clay-coloured Sparrow, Field Sparrow, Black-billed Cuckoo, Eastern Towhee, Willow Flycatcher, Blue-winged Warbler, Brewster's Warbler, Tennessee Warbler, Palm Warbler, Connecticut Warbler, Wilson's Warbler, Prairie Warbler, Lincoln's Sparrow, Northern Cardinal, Orchard Oriole, Golden-winged Warbler (SPECIAL CONCERN), Yellow-breasted Chat (SPECIAL CONCERN)
Significant Wildlife Habitat Category:	Habitat of Species of Conservation Concern
Functional Habitat:	Breeding Habitat
Habitat Features:	Shrubland or successional fields that are not being actively farmed The Whip-poor-will (THREATHENED) is protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be contacted if any development proposals have the potential to affect Whip-poor-will breeding areas.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Some of the species nesting in these habitats may not require extensive areas, but have very specific habitat requirements which limit their distribution. For these species, shrubby areas provide essential food, cover and nesting habitat.

The primary requirements of these shrub/early successional birds are highly variable. See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

Shrubland species are at high risk because the habitat that they depend on is generally considered wasteland with limited ecological value. These habitats are often considered prime development areas, and they are frequently planted to trees. Some of the species covered by this index are experiencing declines. Many other shrubland birds that have declining populations were not included in this index because they are still common in the province.

Development which affects habitat supporting any of these bird species will affect the use of this significant wildlife habitat. Other species in this guild are considered special concern in the province, and the guidelines for the PPS suggest that, at a minimum, the best examples of habitat for special concern species are to be maintained.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Residential or commercial development which reduces the amount of suitable habitat will affect the number of birds which can use the shrubland for breeding. Most birds are territorial during the nesting season and must retain a large enough area to forage and provide for their offspring. Reductions in the area of shrubland will result in the loss of nesting territories, nesting cover and/or a reduction in the amount of food available to birds. The net result is a reduction in brood success.

Site alterations which change the composition or structure of shrublands or which result in the conversion of open shrubby areas to forest (i.e., tree planting or prevention of fire or grazing which once kept the area open) will have negative impacts on shrubland birds. Many of these species have very specific microhabitat requirements; any changes in these will be detrimental.

Residential developments which result in there being many free-ranging pets (cats and dogs) will affect nest success by introducing significant predation to the area. Human incursion into the nesting habitat may also lead predators to nests.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of SWH is the contiguous ELC field/thicket ecosite.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing field/thicket habitat for development will result in its loss under the footprint of the development, and reduced ecological function in the remaining habitat due to fragmentation. Human disturbance associated with the development (e.g., people and pets) will further reduce the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected.

The area left should always be in one large patch rather than split up or fragmented. Patch shape is also important, much the same as for interior forest habitat. Clustering development may reduce the amount of habitat that is affected.

Impact Assessments will address drainage, habitat structure, and human and pet usage. Stormwater management studies and, in some cases, hydro-geological studies, will be required to determine if changes in shrubland moisture regimes will occur. If changes may occur, then impacts on vegetation composition and structure should be determined along with ramifications on significant shrubland species or on the structure of the vegetation within the shrubland.

Even if drainage patterns and most of the shrubland are maintained, management (or lack of intervention) may be required. Landowners may consider an adjacent old field to be a weedy eyesore. The temptation to plant trees or mowing must be averted. Interpretational signs or other educational techniques should be employed so that residents understand that they are living adjacent to significant wildlife habitat and species. However, the reality is that interpretation often does not work.

Unless tree growth in the area is inhibited by depth of soil or moisture, shrublands will revert to forest habitat if left undisturbed. If shrublands are set aside from development to protect habitat for shrubland-breeding birds, the area should be deeded to a municipality or conservation authority or other agency which should be responsible for maintenance of the habitat to ensure that it continues to function as shrubland habitat for breeding birds.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses are the type of major recreational development that is most likely to affect shrubland habitat. Conversion of shrublands into fairways, tees, and greens will result in direct loss of habitat.

Site alterations which change the composition or structure of shrublands or which result in the conversion of open shrubby areas to manicured grass (e.g., golf courses) or to forest (i.e., tree planting or prevention of fire or grazing which once kept the area open) will have negative impacts on shrubland birds. Many of these species have very specific microhabitat requirements; any changes in these will be detrimental.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of SWH is the contiguous ELC field/thicket ecosite.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing field/thicket habitat for development will result in its loss under the footprint of the development, and reduced ecological function in the remaining habitat due to fragmentation. Human disturbance associated with the development (e.g., people, golf carts, maintenance machinery) will further reduce the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat.

When complete avoidance is not possible, it may be feasible to incorporate retained shrublands into the golf course design. Areas of rough and other areas that are not used for active play could be maintained as shrubland or planted to suitable shrub species. Lay out fairways so that they avoid the central portion of the shrubland, and minimize fragmentation of retained shrubland habitat.

Golf course development should never reduce the amount of suitable habitat below the threshold size required by any area-sensitive species that occur in the area as this will result in a negative impact on the habitat. Generally, if the amount of habitat that remains is large enough to support the most sensitive species, all other species should be protected.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Shrublands are most likely to be affected by development of sand and gravel pits and stone quarries.

Excavation activities that reduce the amount of suitable habitat will affect the number of birds which can use the shrubland for breeding. Most birds are territorial during the nesting season and must retain a large enough area to forage and provide for their offspring. Reductions in the area of shrubland will result in the loss of nesting territories, nesting cover and/or a reduction in the amount of food available to birds. The net result is a reduction in brood success.

Loss of shrubland habitat may be temporary or permanent, depending upon whether extraction occurs below the water table and whether a pit or a quarry is involved.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of SWH is the contiguous ELC field/thicket ecosite.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing field/thicket habitat for development will result in its loss under the footprint of the development, and reduced ecological function in the remaining habitat due to fragmentation. Human disturbance associated with the development (e.g., people and machinery) will further reduce the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat.

However, the PPS requires a balance of uses and aggregate extraction is a high priority. Unless the shrubland supports a highly significant bird community, including populations of species of conservation concern, it is highly likely that the aggregate resources will be of greater significance.

If possible, extraction should never reduce the amount of suitable habitat below the threshold size required by any area-sensitive species that occur in the area as this will result in a negative impact on the habitat. Generally, if the amount of habitat that remains is large enough to support the most sensitive species, all other species should be protected. Therefore, a good inventory of the species that are using a particular site is very important.

The area left needs to be in one large patch rather than split up or fragmented. Patch shape is also important, much the same as for interior forest. Clustering development may reduce the amount of habitat that is affected.

If extraction does not occur below the water table, it may be possible to rehabilitate pits to shrublands once the aggregate resources have been exhausted. Pit rehabilitation offers unique opportunities for shrubland restoration because the amount of topsoil that is available over the relatively sterile soils of the pit floor can be controlled. Therefore, the substrate depth can be designed so that tree growth will be inhibited, thus reducing or obviating the need for periodical maintenance to ensure that the shrublands remain viable.

Often pit and quarry properties contain areas that do not have any aggregate resources, or where they are of inferior quality or covered by too much overburden to make it economically viable to extract these areas. If such areas are available, thought should be given to managing them for shrubland birds.

ENERGY DEVELOPMENT

Potential Development Effects: Biofuel Farms

The ploughing and subsequent conversion of grassland habitat to farmland for the production of crops for ethanol (e.g., biomass feedstock such as corn and soy) will destroy field/thicket breeding bird habitat. Many bird species will avoid monocultures, and those birds that continue to use such areas may have their nests destroyed during ploughing or harvesting of crops.

Mitigation Options: Biofuel Farms

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of SWH is the contiguous ELC field/ thicket ecosite.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Development on field/thicket habitat will result in loss of that portion of the habitat that is under the development footprint. The best mitigation is to avoid developing biofuel farms in grassland habitat.

Where complete avoidance is not possible, consider cultivating Switchgrass rather than corn or soy for biofuel production. Switchgrass is a native, perennial warm season grass in Ontario (Tallgrass Ontario 2004). Cultivating Switchgrass may benefit the field nesting members of the shrub/early successional guild. Additionally, retain the shrubby elements in marginal portions of farmland. These may include damp fields and fencerows.

Potential Development Effects: Wind Power Facilities

The primary impact of wind power facilities on shrubland birds appears to be the direct loss of habitat, from construction of pads for turbines and permanent access roads.

Operation of turbines has the potential to result in direct mortality of shrubland birds due to being struck by turbine blades. There is also the potential that nesting shrubland birds will exhibit avoidance behaviour to turbines, thus resulting in an indirect loss of nesting habitat.

Although monitoring data from Ontario wind power facilities are still relatively scarce, more information is being collected all the time. Available information indicates that bird strikes of breeding birds in grassland and agricultural habitats are relatively rare and unlikely to be a limiting factor to most species.

James (2003, 2008) found no aversion of grassland bird species to turbines. Many species nested in close proximity to the turbines or foraged near them. The only species in this guild that occurred in his study area was the Red-headed Woodpecker, and it showed no aversion to the turbines.

Currently, there are limited data on the effects of wind power facilities on breeding birds, with most work focused on migrating birds. In Minnesota, Osborn et al. (2000) studied bird mortality for a full-year period and determined that an average of 1 bird per turbine was killed annually. The wind farm was situated in an agricultural setting with some grassy areas and isolated woodlands. The authors concluded that bird mortality in a grassland/cropland landscape was low and that wind turbines do not appear to kill more birds than other human-made structures.

Drewitt and Langston (2006) stated that the effects of turbines on displacement of breeding birds are largely inconclusive or suggest low-disturbance distances. Most work has been done on long-lived birds with high site-fidelity and therefore the true impacts on these species may only be evident over a long period of time. Few studies have focused on short-living passerines such as the studies by James (2003, 2008).

In the United Kingdom, Devereux et al. (2008) found that wind turbines had minimal effects on the distribution of wintering farmland birds.

From the available information, it does not appear that wind power facilities result in significant mortality of breeding birds or cause a significant avoidance reaction. This, however, needs more study and may be species-specific in some cases.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the edge of shrub/early successional bird breeding SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. The area of SWH is the contiguous ELC field/thicket ecosite. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing field/thicket habitat for development will result in its loss under the footprint of the development, and reduced ecological function in the remaining habitat due to fragmentation. Human disturbance associated with the development (e.g., construction and regular maintenance activities) will further reduce the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected.

In some cases, it may be possible to manage some of the area that is not directly affected by the development for shrubland birds. In this event, the land should be deeded to a public agency that can do the required monitoring and management to maintain habitat for shrubland bird species.

Development activities occurring adjacent to large areas of shrubland habitat should always consider sensitive periods of various species of concern. For example, noisy disturbances such as excavation or blasting should be scheduled to avoid periods when birds are nesting or raising fledglings.

Potential Development Effects: Solar Power Facilities

Any development that reduces the amount of suitable habitat will affect the number of birds which can use the shrubland for breeding. Most birds are territorial during the nesting season and must retain a large enough area to forage and provide for their offspring. Reductions in the area of shrubland will result in the loss of nesting territories, nesting cover and/or a reduction in the amount of food available to birds. The net result is a reduction in brood success. By design, solar panels capture sunlight that would normally reach the habitat. A dramatic reduction in sunlight will have significant impacts on the underlying plant community, likely leading to the loss of vegetation biomass and structure.

Site alterations which change the composition or structure of shrublands will have negative impacts on shrubland birds. Many of these species have very specific microhabitat requirements; any changes in these will be detrimental.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of the edge of shrub/early successional bird breeding SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The area of SWH is the contiguous ELC field/thicket ecosite. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing field/thicket habitat for development will result in its loss under the footprint of the development, and reduced ecological function in the remaining habitat due to fragmentation. Human disturbance associated with the development (e.g., construction and operational maintenance) will reduce the ecological function of adjacent retained habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Clustering the solar panels together as much as possible will also reduce fragmentation and minimize the development footprint. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected.

The area left should always be in one large patch rather than split up or fragmented. Patch shape is also important, much the same as for interior forest habitat.

Development activities occurring adjacent to large areas of shrubland habitat should always consider sensitive periods of various species of concern. For example, noisy disturbances such as clearing, grading, excavation and drilling should never be scheduled around periods when birds are nesting or raising fledglings.

Impact Assessments will address drainage, habitat structure, and human usage. Stormwater management studies and, in some cases, hydro-geological studies, will be required to determine if changes in shrubland moisture regimes will occur. If changes may occur, then impacts on vegetation composition and structure should be determined along with ramifications on significant shrubland species or on the structure of the vegetation within the shrubland.

Unless tree growth in the area is inhibited by depth of soil or moisture, shrublands will revert to forest habitat if left undisturbed. If shrublands are set aside from development to protect habitat for shrubland-breeding birds, the area should be deeded to a municipality or conservation authority or other agency which should be responsible for maintenance of the habitat to ensure that it continues to function as shrubland habitat for breeding birds.

ROAD DEVELOPMENT

Potential Development Effects

The footprint of a road will result in direct habitat loss for shrubland-nesting birds.

Roads have the potential to fragment the remaining shrubland habitat and make the resulting patches too small to support certain area-sensitive species. Depending on how the road is routed through shrubland habitat, fragmentation of habitat may occur such that it is no longer large enough to support species with large territories or that are area-sensitive.

Roads may also act as a barrier to movement of surface water and shallow groundwater. This may result in one side of the road becoming wetter and the other drier. This may affect the quality of the shrubland and the species of shrubs that it can support.

Compounds containing salt are typically used to de-ice roads in winter. Airborne salt spray can travel considerable distances depending upon wind velocity and the speed at which vehicles are traveling. Direct contact with salt spray can kill some vegetation species, and build-up of salt concentrations within surface and ground water over time may affect a wide variety of other species. Roadsides may also become dominated by halophytic plant species, most of which are non-native.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of SWH is the contiguous ELC grassland ecosite.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing shrubland habitat for development will result in its loss under the footprint of the development, and reduced ecological function in the remaining shrubland due to fragmentation. Human disturbance associated with the development (e.g., noise and motion from passing vehicles, and disturbance from pedestrian traffic) will further reduce the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option. The location of species of conservation concern should be taken into account when routing the road. For instance, directing the road along the edge of the habitat may be the optimum route for most species, but may be deleterious to the Golden-winged Warbler that typically includes a small strip of woodland within its territory.

Development activities occurring adjacent to large areas of shrubland habitat should always consider sensitive periods of various species of concern. For example, noisy disturbances such as excavation or blasting should never be scheduled around periods when birds are nesting or raising fledglings.

Sufficient culverts should be installed under the road to ensure free passage of surface water and shallow groundwater.

Consideration should be given to using de-icing compounds other than salt through grassland habitat.
No herbicides should be used along the roadside to control vegetation.

INDEX #34: AREA-SENSITIVE BIRD BREEDING HABITAT

Ecoregions:	6E, 7E
Species Group:	Area-Sensitive Bird Species: Yellow-bellied Sapsucker, Red-breasted Nuthatch, Pileated Woodpecker, Veery, Blue-headed Vireo, Northern Parula, Black-throated Green Warbler, Blackburnian Warbler, Black-throated Blue Warbler, Ovenbird, Scarlet Tanager, Winter Wren, Cerulean Warbler (SPECIAL CONCERN), Canada Warbler (SPECIAL CONCERN)
Significant Wildlife Habitat Category:	Habitat of Species of Conservation Concern
Functional Habitat:	Breeding Habitat
Habitat Features:	Large, mature woodlands with interior habitat > 200 m from edge

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

The species group for this index was originally called "forest interior birds". The term forest-interior was introduced by Whitcomb et al. (1981) who classified forest birds into four categories: forest interior specialists, interior-edge specialists, edge species, and field-edge species. This classification system was widely adopted and is still used by some. Villard (1998) reviewed the terms forest interior and area-sensitive and concluded that: 1) few species appear to be true forest interior species (avoiding forest edges); 2) even in species that exhibit significant edge avoidance, the distribution of territories may not differ significantly from that of randomly placed territories; and 3) few studies have reported reproductive data to demonstrate the presence of forest-interior species as defined by Whitcomb et al. (1981).

The terms forest interior and area-sensitive are sometimes considered to be synonymous and they are often used interchangeably. However, edge-related effects on reproductive success, edge avoidance, and area sensitivity are distinct phenomena (Villard 1998). The term area-sensitive has been used for this index as it appears to be a better descriptor of the species within this guild. Indeed, some of the birds within this guild are obligate edge species that require large tracts of forest.

There is also some difference in opinion as to which species are area-sensitive. Freemark and Collins (1992) defined area-sensitive species as those that occur more frequently, or increase in density, as fragment size increases. Other studies (Robbins et al. 1989) have identified minimum threshold forest sizes required to support area-sensitive species. For many area-sensitive species, the forest must be considerably larger than their territory size before the forest is occupied. For instance, some birds with territory sizes of less than 1 ha may not inhabit forests smaller than 20 to 30 ha or more.

To further complicate application of this index, the sensitivity of an individual species to forest fragmentation varies geographically. Results from one study area may not be directly transferable to another. Birds that are nesting in areas where forest cover is sparse tend to require larger forests than those of the same species that are nesting where forest cover is abundant (Riley and Mohr 1994). In areas of abundant forest cover, area sensitivity may completely break down and species typically associated with very large forests may successfully breed in small forest fragments. Therefore, a species that may require 100 ha of forest in Essex County may nest in very small woodlots on the Bruce Peninsula or in northern Grey County.

It also appears as though rare species inhabit only the best available habitat while common species may be more widespread, nesting in what humans would call marginal habitat. So the same species may require more forest habitat at the extremes of its range than in the core of its range. The Sora, a wetland bird, is a good example of this phenomenon. In Ontario and Michigan, where it is common, habitat size is not important and it frequently nests in wetlands 0.4 ha and smaller (Berger 1951). In Vermont, where it is uncommon, and in New York, where it is declining, it is restricted to large marshes (Laughlin and Kibbe 1985; Andrle and Carroll 1988).

Birds vulnerable to forest fragmentation require large continuous blocks of forest for successful nesting. Forests provide shelter, nesting habitat, and food for these birds. This is a large guild of species, and their habitat requirements are not fully understood, although more information is becoming available all the time. It appears that when species are nesting in forests near the minimum size that they inhabit, they nest in the interior. As forest size increases, they may nest throughout the forest, even on edges. This may be due to microclimate conditions near edges that result in the habitat being marginal or unsuitable. Some species that require large forested tracts nest only on the edge and avoid the interior, resulting in susceptibility to forest fragmentation. In certain cases, however, these edge species may actually benefit from forest fragmentation provided that the residual forest patches are not too small.

The habitat requirements of breeding birds susceptible to habitat fragmentation are extremely variable and complex. For some, the total amount of woodland in the regional landscape is more important than the size of the woodlot that is selected for nesting (Robbins et al. 1989). Shape and size of woodlots are critical to other species; woodlots with irregular edges and openings within the forest have a lower potential to support species that prefer forest interior. Some species may nest near woodland edges or openings, but still require extensive forest cover. Other important variables may include moisture regime, stand maturity, density of understory, and tree species composition.

Forest fragmentation effects on breeding birds are generally a concern only in off-Shield southern Ontario. Therefore, species which may be susceptible to forest fragmentation but that do not normally breed in the south have been excluded from further consideration. These are Olive-sided Flycatcher, Ruby-crowned Kinglet, Swainson's Thrush, Philadelphia Vireo, Cape May Warbler, Palm Warbler, Bay-breasted Warbler, Blackpoll Warbler, Connecticut Warbler, Wilson's Warbler, Dark-eyed Junco, Red Crossbill, and White-winged Crossbill. However, these principles can still be applied to development on the Shield.

See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

Each species in this index has specific habitat requirements and those habitat requirements may vary depending upon the local landscape and the amount of forest cover that it supports. The requirements of individual species may also depend upon whether it is in the core of its range or at the periphery. Therefore, when considering impacts of a proposed development, all species that breed within the woodland should be considered as well as their context within the landscape.

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Development may have major impacts on birds susceptible to forest fragmentation. Impacts may occur in several ways. The most obvious is direct habitat loss. This occurs when forest cover is removed or when houses, roads, or service corridors encroach into the forest. Species most at risk include any area-sensitive species when the total forest size declines below its threshold size, area-sensitive species that are obligate forest-edge nesters and species that nest in the interior. Those that are nesting in the interior are most at risk, because the loss of a small amount of forest has the potential to result in loss of a disproportionately large amount of forest interior. Those nesting at the edge could potentially benefit from limited fragmentation provided the residual forest patches remain large enough. In extensive forests, fragmentation due to residential roads and utility corridors may improve habitat for some species, but be detrimental to other species. Therefore, it is important to assess potential impacts on all species that are present.

Indirect effects include increased predation, parasitism, and disturbance. These effects may be more significant over the long term, resulting in slow population declines until species are eventually extirpated from the forest.

Forest fragmentation results in a smaller block of habitat, which facilitates nest location by predators and parasites. Fragmentation also increases edge, which favours common, generalist species, many of which are direct predators of nesting birds. Predators fall into two groups: birds and mammals. Predatory birds include edge species such as Blue Jays, American Crows, and Common Grackles. Primary mammalian predators include Virginia Opossum, Gray Squirrel, Eastern Chipmunk, Striped Skunk, Raccoon, Coyote, Red Fox, and domestic cats. Most of the edge bird species are more abundant and nay have more broods annually, and may be direct competitors for resources with forest-dependent species. With this suite of predators, both nests on the ground and low in the canopy are at risk of predation.

Creation of edge or corridors through forests facilitates nest-finding by the Brown-headed Cowbird. This species is an obligate nest parasite which lays its eggs in the nest of other birds. The host bird often raises the cowbird young at the expense of its own.

Development on adjacent lands may have impacts on species in this guild. The activities of humans and their pets in woodlots adjacent to developments may reduce breeding success of some species and eventually lead to a loss of bird species diversity. Some of the area-sensitive bird species that nest on edges also require adjacent open habitats. If these areas are developed, they may be adversely affected. Heavy human usage of forests may result in loss of forest structure. Different bird species are attracted to each level in the forest, so a loss of forest structure may reduce bird species diversity.

Phillips et al. (2005) studied the impacts of low density housing developments on Wood Thrushes in southern Ontario. Birds nesting in woodlots with houses embedded in the forest experienced higher rates of parasitism than those nesting where houses were within 100 m of the woodland but not within it, and than in woodlands where there were no houses nearby. Near Peterborough, predation rates were higher in woodlots with adjacent or embedded houses than in areas with no houses, but near Ottawa there was no increase in predation rates as a result of development. They concluded that the effects of housing appear to be region specific. This caveat is probably true for most species and has also been demonstrated for the Cerulean Warbler (Hamel 2000a). In general, cowbird parasitism rates are greatest in western North America, and lower in landscapes with high forest cover.

Forest thinning and harvesting, and removal of trees considered hazardous to humans (i.e., loss of forest structure) can be detrimental to many species. Those most at risk are those that require mature forests, large trees for nesting or roosting, that hunt in the understory where there is a minimum of shrubs and saplings, and that require snags. Forest thinning can make the forest more attractive to deer, and they can decimate the understory and shrub layer. On the other hand, many area-sensitive species benefit from forest thinning, as this opens up the canopy and promotes growth of shrubs and saplings. These components of habitat are required by several species. It should be recognized that preserving a woodland to eventually create old-growth forest may be beneficial to several species but detrimental to others.

Another potential effect of forest fragmentation is the decline in the amount of forest habitat within the landscape. Once a landscape is less than 30% forested, forest-dependent bird species start to disappear. The first to disappear are those that require very large forested tracts and those that nest in forest interior habitat. Once the amount of forest habitat declines to 15 to 20% of the landscape, about 20% of the forest-dependent bird species will have disappeared. If the amount of forested habitat declines to as low as 5%, about 80% of the forest-dependent bird species are likely to disappear (Environment Canada 2004).

The following table summarizes the general susceptibility of species in this index to indirect effects of development. All are susceptible to direct habitat loss and reducing forests sizes to below the area that they usually require. In the table, the column on human disturbance refers to people walking through the woods and not forestry practices or other activities that may alter forest structure. Information in this table has been generated by information provided in Peck and James (1983, 1987) and the Birds of North America species accounts.

Species	Avian predators	Mammalian predators	Parasitism	Human disturbance
Yellow-bellied Sapsucker	very low	none	none	low
Red-breasted Nuthatch	very low	none	low	low
Pileated Woodpecker	very low	none	none	low
Winter Wren	very low	moderate	none	low
Veery	high	high	moderate	low
Blue-headed Vireo	high	very low	low	low
Northern Parula	moderate	very low	low	low
Black-throated Blue Warbler	moderate	high	low	low
Black-throated Green Warbler	high	low	moderate	low
Blackburnian Warbler	high	very low	moderate	low
Cerulean Warbler	moderate	very low	moderate	low
Ovenbird	low	high	low	low
Scarlet Tanager	moderate	moderate	moderate	low
Canada Warbler	moderate	high	moderate	low

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and other site alterations for development in area sensitive bird breeding habitat will destroy the affected habitat, and reduce ecological function in the remaining habitat due to fragmentation. Human disturbance associated with the development (e.g., people and pets) may also reduce ecological function in adjacent retained habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected.

When considering mitigation, it is important to consider all species present in the existing woodland and how they may be affected by the proposed development. This will help to determine which species are most likely to be adversely affected, and there may be positive benefits for some species. This analysis will define those species for which mitigation should be directed towards. Emphasis should be on species at risk and those that have the most demanding habitat requirements. The analysis should also take into account proposed management of the residual woodland when predicting which species will be affected. A different suite of forest birds will result in woodlands that are preserved than in those that are periodically managed.

It may be difficult to totally mitigate the effects of development on populations of area-sensitive birds. Any site alteration which results in an opening in the forest canopy will allow the woodland to be invaded by competitive birds from the forest edge and surrounding open areas. Even temporary roads traversing woodlots can have lasting impacts on these birds that are adversely affected by openings. Openings, however, may be beneficial to numerous species, depending upon the nature of the opening.

The optimum method is to determine which species are most sensitive to development and design the project to protect these species. If this is accomplished, most other species of concern should be protected provided that the ultimate management (or lack thereof) of the woodland is taken into account. The area of the woodlot should never be decreased below the minimum size required for the most area-sensitive species as this will result in a negative impact on the habitat.

There may be instances where the woodland supports area-sensitive species that nest on the forest edge. Some of these may require adjacent open areas during the breeding season. In these instances, it may be necessary to leave a buffer of open area between the forest and the development.

Development could possibly be clustered instead of having houses dispersed throughout the forest or around it. Development should always be restricted to the edge of habitat instead of occurring centrally. The size and shape of many woodlots can be improved by tree planting to increase the amount of forest interior.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses and ski resorts are the types of major recreational developments that are most likely to have effects on area-sensitive breeding birds.

Development may have major impacts on birds susceptible to forest fragmentation. Impacts may occur in several ways. The most obvious is direct habitat loss. This occurs when forest cover is removed. Species most at direct risk include any area-sensitive species when the total forest size declines below its threshold size, area-sensitive species that are obligate forest-edge nesters and species that nest in the interior. Those that are nesting in the interior are most at risk, because the loss of a small amount of forest has the potential to result in loss of a disproportionately large amount of forest interior. Those nesting at the edge could potentially benefit from limited fragmentation provided the residual forest patch remains large enough. In extensive forests, fragmentation due to roadways, utility corridors or golf holes may improve habitat for some species, but be detrimental to other species. Therefore, it is important to assess potential impacts on all species that are present.

Indirect effects include increased predation, parasitism, and disturbance. These effects may be more significant over the long term, resulting in slow population declines until species are eventually extirpated from the forest.

Forest fragmentation results in a smaller block of habitat, which facilitates nest location by predators and parasites. Fragmentation also increases edge, which favours common, generalist species, many of which are direct predators of nesting birds. Predators fall into two groups: birds and mammals. Predatory birds include edge species such as Blue Jays, American Crows, and Common Grackles. Primary mammalian predators include Virginia Opossum, Gray Squirrel, Eastern Chipmunk, Striped Skunk, Raccoon, Coyote, Red Fox, and domestic cats. Most of the edge bird species are more abundant and have more broods annually, and may be direct competitors for resources with forest-dependent species. With this suite of predators, both nests on the ground and low in the canopy are at risk of predation.

Creation of edge or corridors through forests facilitates nest-finding by the Brown-headed Cowbird. This species is an obligate nest parasite which lays its eggs in the nest of other birds. The host bird often raises the cowbird young at the expense of its own.

The following table summarizes the general susceptibility of species in this index to indirect effects of development. All are susceptible to direct habitat loss and reducing forests sizes to below the area that they usually require. In the table, the column on human disturbance refers to people walking through the woods and not forestry practices or other activities that may alter forest structure. Information in this table has been generated by information provided in Peck and James (1983, 1987) and the Birds of North America species accounts.

Species	Avian predators	Mammalian predators	Parasitism	Human disturbance
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Black-throated Green Warbler	high	low	moderate	low
Blackburnian Warbler	high	very low	moderate	low
Cerulean Warbler	moderate	very low	moderate	low
Ovenbird	low	high	low	low
Scarlet Tanager	moderate	moderate	moderate	low
Canada Warbler	moderate	high	moderate	low

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and other site alterations for development in area sensitive bird breeding habitat will destroy the affected habitat, and reduce ecological function in the remaining habitat due to fragmentation. Human disturbance associated with the development (e.g., people, golf carts) may also reduce ecological function in adjacent retained habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected.

When considering mitigation, it is important to consider all species present in the existing woodland and how they may be affected by the proposed development. This will help to determine which species are most likely to be adversely affected, and there may be positive benefits for some species. This analysis will define those species for which mitigation should be directed towards. Emphasis should be on species at risk and those that have the most demanding habitat requirements. The analysis should also take into account proposed management of the residual woodland when predicting which species will be affected. A different suite of forest birds will result in woodlands that are preserved than in those that are periodically managed.

When designing ski runs or golf course fairways, these linear cuts into forest habitat needs to be aligned so that they affect the least amount of forest interior habitat. Ideally, these would be situated out of forested habitat, but this is not always possible. If possible, openings in woodlands should be created near existing edges to minimize fragmentation. The Environmental Impact Assessment should identify locations of area-sensitive species within the forest and look at how much forest-interior habitat is initially present and compare that with different development scenarios.

It may be difficult to totally mitigate the effects of development on populations of area-sensitive birds. Any site alteration which results in an opening in the forest canopy will allow the woodland to be invaded by competitive birds from the forest edge and surrounding open areas. Openings, however, may be beneficial to numerous species, depending upon the nature of the opening.

The optimum method is to determine which species are most sensitive to development and design the project to protect these species. If this is accomplished, most other species of concern should be protected provided that the ultimate management (or lack thereof) of the woodland is taken into account. The area of the woodlot should never be decreased below the minimum size required for the most area-sensitive species as this will result in a negative impact on the habitat.

There may be instances where the woodland supports area-sensitive species that nest on the forest edge. Some of these may require adjacent open areas during the breeding season. In these instances, it may be necessary to leave a buffer of open area between the forest and the active area of a golf course or ski run.

On golf courses, it may be possible to plant trees adjacent to retained forested areas to improve habitat for area-sensitive species. Areas not used for active play could be reforested to improve habitat.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Pits and quarries south of the Shield have the potential to affect area-sensitive breeding birds. Although mining may affect these species on the Shield, area-sensitive breeding birds are widespread and abundant and it is unlikely that any examples of area-sensitive bird habitat will be identified as Significant Wildlife Habitat in the north.

Due to the poor or shallow soils in areas that are suitable for pits and quarries, these sites tend to be open in nature but may include edges of forests that support area-sensitive breeding birds. For the most part, pits and quarries will affect the edges of forests as opposed to central portions.

Removal of forested habitat for pits and quarries can reduce the overall size of the forest and also reduce the amount of forest interior habitat. This has the potential to reduce the size of the resulting patch below that required for some of the area-sensitive breeding birds.

As additional edge is created, or the edge penetrates farther into the forest, nest predation and parasitism rates may increase, thus reducing the reproductive success of area-sensitive species.

Dewatering activities or drawing down of the local water table may affect the remaining woodland, particularly if it is a swamp. Drying may result in the eventual death of trees and replacement of wetland species by more upland species.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and excavating development in area-sensitive bird breeding habitat will result in loss of the habitat under the footprint of the development, and reduced ecological function in the remaining habitat due to fragmentation. Human disturbance associated with the development (e.g., people and machinery) will further reduce the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat.

When complete avoidance is not possible, it may be feasible to mitigate impacts by planting additional forest. Preferably this would be done on the other side of the same woodland so that over the long-term it was at least as functional in providing habitat for area-sensitive birds. In some cases, establishment of forest cover could occur in other locations but preferably nearby.

Hydrogeological studies may be required to determine if the water table will be lowered in retained forest and if this has the potential to affect area-sensitive species by dying of trees or replacement of existing tree species with others. If adverse effects may occur, mitigation may include limiting the depth of extraction, pumping water to the woodland, creating an impermeable barrier around portions of the pit or quarry, or establishing recharge wells. The later mitigation method has been proposed for a number of quarries, but the efficiency of this in maintaining water table levels has yet to be determined.

If extraction does not occur below the water table, it may be possible to rehabilitate pits and quarries to forest habitat once the aggregate resources are exhausted. This will be more easily accomplished for pits, but sufficient soils will need to be spread over the mined-out area to ensure suitable growth rates of trees. Quarries represent a greater challenge for rehabilitation of woodlands as they tend to be deep with very steep slopes even after the sides have been back-filled. In addition, there is typically no soil in the bottom of quarries so that the growing medium will have to be imported. Hydrogeological studies may be required to determine if the water table will be such that it will allow establishment of forest cover within a rehabilitated quarry.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Development may have major impacts on birds susceptible to forest fragmentation. Impacts may occur in several ways. The most obvious is direct habitat loss from forest clearing for the development and associated components (e.g., access roads). Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Clearing for construction of pads for turbines and permanent access roads will destroy habitat under the footprint of the development, and fragment the remaining habitat.

Species most at risk from habitat loss and fragmentation include any area-sensitive species when the total forest size declines below its threshold size, area-sensitive species that are obligate forest-edge nesters, and species that nest in the interior. Those that are nesting in the interior are most at risk, because the loss of a small amount of forest has the potential to result in loss of a disproportionately large amount of forest interior. Those nesting at the edge could potentially benefit from limited fragmentation provided the residual forest patches remain large enough. In extensive forests, fragmentation due to residential roads and utility corridors may improve habitat for some species, but be detrimental to other species. Therefore, it is important to assess potential impacts on all species that are present.

Indirect effects of habitat fragmentation include increased predation, parasitism, and disturbance. These effects may be more significant over the long term, resulting in slow population declines until species are eventually extirpated from the forest.

Forest fragmentation results in a smaller block of habitat, which facilitates nest location by predators and parasites. Fragmentation also increases edge, which favours common, generalist species, many of which are direct predators of nesting birds. Predators fall into two groups: birds and mammals. Predatory birds include edge species such as Blue Jays, American Crows, and Common Grackles. Primary mammalian predators include Virginia Opossum, Gray Squirrel, Eastern Chipmunk, Striped Skunk, Raccoon, Coyote, Red Fox, and domestic cats. Most of the edge bird species are more abundant and nay have more broods annually, and may be direct competitors for resources with forest-dependent species. With this suite of predators, both nests on the ground and low in the canopy are at risk of predation.

Creation of edge or corridors through forests facilitates nest-finding by the Brown-headed Cowbird. This species is an obligate nest parasite which lays its eggs in the nest of other birds. The host bird often raises the cowbird young at the expense of its own.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the edge of area-sensitive bird breeding SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on raptor wintering habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in area-sensitive breeding bird habitat will result in loss of the habitat under the footprint of the development, and reduced ecological function in the remaining habitat due to fragmentation. Human disturbance associated with the development (e.g., people and pets) will further reduce the ecological function of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected. The Significant Wildlife Habitat Technical Guide recommends that forests should cover about 30% of the regional landscape to provide minimal conditions for area-sensitive species, and there should be several large woodlands (30 to 100+ ha) present to provide enough suitable forest-interior bird nesting habitat. The minimum forest habitat for area-sensitive species is at least 100 metres from any edge habitat. Edges can have adverse effects on forest-interior habitat. For example, some forest birds may nest near or in forest edge habitat and then suffer reduced reproductive success because of nest predation and parasitism (OMNR 2000).

Potential Development Effects: Solar Power Facilities

Development may have major impacts on birds susceptible to forest fragmentation. Impacts may occur in several ways. The most obvious is direct habitat loss. This occurs when forest cover is removed. Species most at risk include any area-sensitive species when the total forest size declines below its threshold size, area-sensitive species that are obligate forest-edge nesters and species that nest in the interior. Those that are nesting in the interior are most at risk, because the loss of a small amount of forest has the potential to result in loss of a disproportionately large amount of forest interior. Those nesting at the edge could potentially benefit from limited fragmentation provided the residual forest patches remain large enough. In extensive forests, fragmentation due to residential roads and utility corridors may improve habitat for some species, but be detrimental to other species. Therefore, it is important to assess potential impacts on all species that are present.

Indirect effects include increased predation, parasitism, and disturbance. These effects may be more significant over the long term, resulting in slow population declines until species are eventually extirpated from the forest.

Forest fragmentation results in a smaller block of habitat, which facilitates nest location by predators and parasites. Fragmentation also increases edge, which favours common, generalist species, many of which are direct predators of nesting birds. Predators fall into two groups: birds and mammals. Predatory birds include edge species such as Blue Jays, American Crows, and Common Grackles. Primary mammalian predators include Virginia Opossum, Gray Squirrel, Eastern Chipmunk, Striped Skunk, Raccoon, Coyote, Red Fox, and domestic cats. Most of the edge bird species are more abundant and nay have more broods annually, and may be direct competitors for resources with forest-dependent species. With this suite of predators, both nests on the ground and low in the canopy are at risk of predation.

Creation of edge or corridors through forests facilitates nest-finding by the Brown-headed Cowbird. This species is an obligate nest parasite which lays its eggs in the nest of other birds. The host bird often raises the cowbird young at the expense of its own.

Another potential effect of forest fragmentation is the decline in the amount of forest habitat within the landscape. Once a landscape is less than 30% forested, forest-dependent bird species start to disappear. The first to disappear are those that require very large forested tracts and those that nest in forest interior habitat. Once the amount of forest habitat declines to 15 to 20% of the landscape, about 20% of the forest-dependent bird species will have disappeared. If the amount of forested habitat declines to as low as 5%, about 80% of the forest-dependent bird species are likely to disappear (Environment Canada 2004).

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of the edge of area-sensitive bird breeding SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing and other site alterations for development in area sensitive bird breeding habitat will destroy the affected habitat, and reduce ecological function in the remaining habitat due to fragmentation. Human disturbance associated with the development (e.g., construction and operational maintenance) will also reduce ecological function in adjacent retained habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Clustering the solar panels together as much as possible will also reduce fragmentation and minimize the development footprint. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected.

When considering mitigation, it is important to consider all species present in the existing woodland and how they may be affected by the proposed development. This will help to determine which species are most likely to be adversely affected, and which species should be targeted for mitigation measures. There may also be positive benefits for some species. Emphasis should be on species at risk and those that have the most demanding habitat requirements. The analysis should also take into account proposed management of the residual woodland when predicting which species will be affected. A different suite of forest birds will result in woodlands that are preserved than in those that are periodically managed.

It may be difficult to totally mitigate the effects of development on populations of area-sensitive birds. Any site alteration which results in an opening in the forest canopy will allow the woodland to be invaded by competitive birds from the forest edge and surrounding open areas. Openings, however, may be beneficial to numerous species, depending upon the nature of the opening.

The optimum method is to determine which species are most sensitive to development and design the project to protect these species. If this is accomplished, most other species of concern should be protected provided that the ultimate management (or lack thereof) of the woodland is taken into account. The area of the woodlot should never be decreased below the minimum size required for the most area-sensitive species.

The area left should always be in one large patch rather than split up or fragmented. Patch shape is also important, much the same as for interior forest habitat.

ROAD DEVELOPMENT

Potential Development Effects

Depending upon their design and location relative to the forested habitat supporting significant habitat for area-sensitive species, roads may have significant impacts on breeding birds.

The width of the road right-of-way can be an important factor in determining impacts on breeding birds. Wider rights-of-way are perceived as a barrier by birds and essentially cut the woodland into two parcels. Narrower rights-of-way may not be perceived as a barrier, and some birds may include both sides of the road in their territory. This is particularly true of canopy-nesting species, if the canopy is allowed to grow over the road. For example, at Vanessa Swamp Cerulean Warblers avoided the edges of the forest but nested along the edge of a county road through the swamp where the tree canopies above the road almost touched.

If a road must pass through a woodland supporting area-sensitive species, its impacts may vary considerably depending upon its location. Roads that pass through the central portion of a woodland typically have the greatest impacts as they remove the most habitat, greatly reduce the size of the forest patches on either side of the road, and greatly reduce the amount of forest-interior habitat. Roads that are routed along the edge of woodlands leave a larger patch of forest intact.

The alignment of a road in relation to specialized habitats within the woodland is also important in determining effects. In many woodlands, there are small patches of habitat that are atypical of the woodland as a whole, and these may attract species that might otherwise be absent. For example, small patches of White Cedar or mature White Pine in an otherwise deciduous forest may support Black-throated Green Warblers. If the new road eliminates these small patches, the species will likely be lost from the woodland.

Roads are used as travel corridors by a number of mammal species that may prey upon bird nests. These include Virginia Opossum, Raccoon, Striped Skunk, Coyote, and Red Fox. Creation of a new road is likely to reduce nesting success near it.

The new opening created by a road will also create new forest edges. This will expose more of the forested area to parasitism by the Brown-headed Cowbird.

Roads often act as barriers to the lateral movement of surface water and shallow groundwater. This may result in flooding on one side of the road and drier conditions on the other side. This in turn may affect adjacent forested areas and their ability to support area-sensitive breeding birds. In areas that become much wetter, the trees often die and are replaced by shrubs or cattail marsh. This further reduces the forest size and creates additional edge effects. Drying may result in swamp tree species gradually dying off and being replaced by intolerant hardwoods such as trembling aspen that may be of lesser value for nesting area-sensitive species.

Creating a new corridor through a woodland may also increase windthrow of trees. Those that are most susceptible are red and silver maple and white cedar. These species are even more vulnerable when they are initially in a wet area that subsequently becomes drier.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing, grading and other site alterations for development in area sensitive bird breeding habitat will destroy the affected habitat, and reduce ecological function in the remaining habitat due to fragmentation. Human disturbance associated with the development (e.g., vehicular and pedestrian traffic) may also reduce ecological function in adjacent retained habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat to minimize habitat fragmentation. Generally, if the amount of retained habitat is large enough to support the most sensitive species present, all other species should be protected.

Ideally, roads would not be routed through significant habitat for area-sensitive breeding birds. There may, however, be occasions when this cannot be avoided. In these instances, the effects can be minimized through careful selection of the route and the design of the road. If a road does pass through a woodland, there are certain effects for which there is no effective mitigation, and there will be residual effects. These include the probability of increased predation and parasitism along the road and direct loss of some habitat for area-sensitive species.

Occasionally it is not possible to change the route of a new road much, as it may be necessary to tie into an existing road or there may other constraints that dictate where it must go. If there are opportunities to move the location of the right-of-way, several factors should be considered to minimize effects on area-sensitive birds.

A route should always be selected that minimizes the amount of forest lost and the amount of interior habitat that is lost. Generally, this will mean situating the road as close to the existing edge of the woodland as possible. Various scenarios should be examined and evaluated for the amount of forest they remove and the size of residual patches of forest that will remain on either side of the road. The size of the remaining patches should be compared to the minimum forest size requirements of the bird species that currently inhabit the forest. The objective should be to maintain sufficient habitat in at least one of the residual forest blocks to support the most demanding area-sensitive species.

Microhabitat areas within the woodland should be identified and avoided if these support bird species that would otherwise be absent. In some cases, simple avoidance may not be enough; there will need to be a large enough forest retained on that side of the road for those individual species.

The width of the road right-of-way needs to be minimized through the woodland. If the right-of-way is 20 m or less in width, many bird species will not recognize this as a significant break. From an ecological perspective, the forest may then remain as a single contiguous forest instead of becoming two or more parcels. This, however, does not reduce impacts due to parasitism or predation. If possible, the trees immediately adjacent to the road should not be trimmed. The canopy should be allowed to develop over the road and this will lessen the effects of forest fragmentation on those species that nest in the canopy.

Sufficient culverts should be installed under the road to ensure free passage of surface water and shallow groundwater.

When planning the alignment of the road corridor, the direction of prevailing winds should be considered if there are tree species present that are susceptible to windthrow. If possible, the road right-of-way should be aligned so that a new edge comprised of these species is not exposed to the prevailing winds.

INDEX #35: MARSH BIRD BREEDING HABITAT

Ecoregions:	All of Ontario
Species Group:	Marsh birds: American Bittern, Virginia Rail, Sora, Red-necked Grebe, Northern Shoveler, Redhead, Ring-necked Duck, Lesser Scaup, Ruddy Duck, Common Moorhen, American Coot, Wilson's Phalarope, Pied-billed Grebe, Marsh Wren, Sedge Wren, Common Loon, Sandhill Crane, Black-crowned Night Heron, Green Heron, Solitary Sandpiper, Black Tern (SPECIAL CONCERN), Yellow Rail (SPECIAL CONCERN)
Significant Wildlife Habitat Category:	Habitat of Species of Conservation Concern
Functional Habitat:	Breeding Habitat The Least Bittern (THREATENED) and the King Rail (ENDANGERED) are protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that may affect these species.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

This index deals primarily with species that nest in marshes, one of the four wetland types that occur in the province. Some species that are dependent on bogs or fens are included, but only if these species appear to be declining and occur in areas that may experience development pressure. Species that nest mostly in swamps are covered under the woodland/forest habitat, although these are also wetlands.

Marshes are preferred habitat for many of Ontario's birds. Some of these are at risk due to the continuing loss of wetland habitat in the province. Others face limiting factors during migration and on their wintering grounds. Degradation or fragmentation of marshes has been detrimental to some species. The status and population trends of some of these species are not well understood, as many are difficult to detect. In some jurisdictions, certain of these species may be locally abundant but considered rare because they are seldom encountered.

This guild contains a diverse assemblage of species, each with specific habitat requirements. Development or management that is detrimental to one species may be advantageous to another. See the Appendix of species descriptions for habitat details about the members of this species group.

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Draining, dredging, excavation, or filling portions of wetlands to establish development will have negative impacts on the both the feature and its ecological function as a nesting area for marshland birds.

Changes to water levels as a result of development will affect distribution of emergent vegetation and, therefore, habitat for marsh-nesting birds. Cattails and other marsh plants are sensitive to water-level fluctuations and depths. As water levels change, so does the density of cattails and other vegetation. As water levels increase, the amount of emergent vegetation declines and the ratio of emergent vegetation to open water decreases. If water levels increase during the nesting season, nests situated near the water's surface may be flooded. As water levels decline, the area of emergents increases as does the ratio of emergents to open water. Lower water levels may expose some nests that were initially built over shallow water, making them more vulnerable to predators, and the lack of open water may discourage some bird species from nesting. If water levels fluctuate more than is normal, this may flood or expose nests. Abnormal water-level fluctuations also stress aquatic plant communities and may favour invasion by species such as purple loosestrife or reed grass. Because marsh birds have specific nest site vegetation density requirements, they will abandon sites when vegetation cover becomes too sparse or too dense. If significant areas of marshland vegetation are affected, then alternate nesting sites within the marsh may not exist. As a consequence, the marsh may cease to function as nesting habitat for certain bird species of conservation concern.

It is important that marshes remain as large as possible. Loss of wetland area will result in there being fewer feeding and nesting areas for birds, or the remnant wetland may not be large enough to support area-sensitive species. The remnant wetland is also likely to be deeper than the original wetland, as the smaller basin will still have to hold the same amount of water. This is likely to change the ratio of open water to emergent vegetation in the wetland and thereby affect its suitability for certain species.

Development on adjacent lands may have major effects on nesting birds owing to impacts on marsh water levels or degradation of water quality. Discharge of sediments or high nutrient loadings to wetlands can affect the distribution of aquatic plants. Increased turbidity due to sediments or algae blooms decreases the depth that sunlight can penetrate the water in the wetland. This decreases the area that is capable of supporting submergent vegetation. As turbidity increases, the plant and aquatic invertebrate communities become simplified and dominated by pollution-tolerant species. In extreme cases, the wetland may fill in prematurely.

Adjacent upland areas may be used by some of these species for foraging or even nesting, such as the American Bittern and Virginia Rail. Development of adjacent areas may reduce the attractiveness of the marsh to these species.

Also, some species are sensitive to human disturbance. If human activity increases in and adjacent to the marsh, some bird species may abandon the area. The species most sensitive to human disturbance, in approximate decreasing order, are Sandhill Crane, Red-necked Grebe (although it has adapted to human use on Lake Ontario and in many areas in the northwest where it nests adjacent to marinas and boat launches on lakes with cottages), American Bittern, American Coot, Common Moorhen (at least formerly, but the species has seriously declined in Ontario), and Little Gull.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC ecosite is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing, dredging and filling for development in marsh bird breeding SWH will destroy the affected habitat; the ecological function of the remaining habitat for nesting will be reduced or lost if the development alters the hydrology of the marsh. Human disturbance associated with the development will further reduce the habitat's ecological function. The best mitigation option is to avoid developing in the habitat. In some cases, habitat may be protected under the provincial wetland policy.

When complete avoidance of the habitat is not possible, and the SWH is very large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; 2) placing it at an edge; and 3) placing it where nest density is lowest. Edge placement will maximize the amount of undisturbed habitat. The retained marsh area must be large enough to support the most area-sensitive species present.

Schedule construction to occur in the fall or winter, when marsh birds are not nesting in the habitat. To mitigate some of the impacts related to human disturbance, consider installing fencing around the development to keep people and machinery off the habitat. If fencing is used, it is very important to ensure that it does not block wildlife movement to/from the habitat. Leave a visual barrier of natural vegetation between the fence and the habitat. These measures may help reduce disturbance impacts related to human activity on the development. Additionally, signage and a public education campaign may help people understand the unique characteristics of the marsh, and the value of leaving it undisturbed.

Even with these mitigation measures in place, developing within marsh bird breeding habitat (even when it is very large) will damage the feature and reduce its ecological function. It may be possible to at least partly compensate for these losses by enhancing or expanding the retained wetland. However, this type of mitigation should never be planned as a trade-off for destroying some of the original wetland. Proponents wishing to enhance wetland functions or size should refer to the Temperate Wetland Restoration Guidelines (Mansell et al. 1998).

Development within a wetland will greatly affect hydrology and therefore plant communities within the wetland. Development will reduce the storage area of the wetland. If the same watershed is maintained, water levels are likely to increase, thereby reducing the extent of vegetation within the marsh. A water balance study should be conducted for any development within a wetland.

Adjacent land development can be benign provided care is taken to ensure that water levels or water quality do not change. Hydrological studies will be required to predict changes in water levels and the duration, magnitude, and frequency of water-level fluctuations. If the wetland receives groundwater inputs, it should be demonstrated that development will not alter the amount of groundwater reaching the wetland. Appropriate stormwater management will be required to ensure that an excess of sediments or nutrients does not reach the wetland. For large-scale developments, a water and nutrient balance may be required to demonstrate that there will be no impact on wetland functions.

The development needs to be designed so as not to encourage heavy human usage of the wetland. Large lots with retention of all shoreline habitat would be preferable. Potential impacts of docks and common roads to the wetland should be determined in an Impact Assessment.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses and marinas are the only type of major recreational development that are likely to affect marshland birds.

Draining, dredging, excavation, or filling portions of wetlands to establish golf course or marina development will have negative impacts on the function of the wetland as a nesting area for marshland birds. Using the wetland as a source of water for golf course irrigation could affect marsh water levels.

It is important that marshes remain as large as possible. Loss of wetland area will result in there being fewer feeding and nesting areas for birds, or the remnant wetland may not be large enough to support area-sensitive species.

Development on adjacent lands may have major effects on nesting birds owing to impacts on marsh water levels or degradation of water quality. Discharge of sediments from parking lots or high nutrient or pesticide loadings from golf courses to wetlands can affect the distribution of aquatic plants. Increased turbidity due to sediments or algae blooms decreases the depth that sunlight can penetrate the water in the wetland. This decreases the area that is capable of supporting submergent vegetation. As turbidity increases, the plant and aquatic invertebrate communities become simplified and dominated by pollution-tolerant species. In extreme cases, the wetland may fill in prematurely.

Also, some species are sensitive to human disturbance. If human activity increases in and adjacent to the marsh, some bird species may abandon the area. Increased boating activity due to new marina development may adversely affect marsh birds through disturbance and potentially destruction of nests by boat wakes.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC ecosite is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing, dredging and filling for development in marsh bird breeding SWH will destroy the affected habitat; the ecological function of the remaining habitat for nesting will be reduced or lost if the development alters the hydrology of the marsh. Human disturbance associated with the development will further reduce the habitat's ecological function. The best mitigation option is to avoid developing in the habitat. In some cases, habitat may be protected under the provincial wetland policy.

When complete avoidance of the habitat is not possible, and the SWH is very large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; 2) placing it at an edge; and 3) placing it where nest density is lowest. Edge placement will maximize the amount of undisturbed habitat. The retained marsh area must be large enough to support the most area-sensitive species present.

Schedule construction to occur in the fall or winter, when marsh birds are not nesting in the habitat. To mitigate some of the impacts related to human disturbance, consider installing fencing around the development to keep people and machinery off the habitat. If fencing is used, it is very important to ensure that it does not block wildlife movement to/from the habitat. Leave a visual barrier of natural vegetation between the fence and the habitat. These measures may help reduce disturbance impacts related to human activity on the development. Additionally, signage and a public education campaign may help people understand the unique characteristics of the marsh, and the value of leaving it undisturbed.

For golf courses, lay out active areas of play as far from the marsh habitat as possible. For marinas, retain as much submergent and emergent vegetation as possible to discourage boating in the nearshore areas of the marsh.

Even with these mitigation measures in place, developing within marsh bird breeding habitat (even when it is very large) will damage the feature and reduce its ecological function. It may be possible to at least partly compensate for these losses by enhancing or expanding the retained wetland. However, this type of mitigation should never be planned as a trade-off for destroying some of the original wetland. Proponents wishing to enhance wetland functions or size should refer to the Temperate Wetland Restoration Guidelines (Mansell et al. 1998).

Development within a wetland will greatly affect hydrology and therefore plant communities within the wetland. Development will reduce the storage area of the wetland. If the same watershed is maintained, water levels are likely to increase, thereby reducing the extent of vegetation within the marsh. A water balance study should be conducted for any development within a wetland.

Adjacent golf course or marina development can be benign provided care is taken to ensure that water levels or water quality do not change. Hydrological studies will be required to predict changes in water levels and the duration, magnitude, and frequency of water-level fluctuations. If the wetland receives groundwater inputs, it should be demonstrated that development will not alter the amount of groundwater reaching the wetland. Appropriate stormwater management will be required to ensure that an excess of sediments or nutrients does not reach the wetland. For large-scale developments, a water and nutrient balance may be required to demonstrate that there will be no impact on wetland functions.

Use of wetlands as a source of irrigation water is unlikely to be possible without adversely affecting the wetland. If this is being contemplated, a water balance study should be completed to determine potential effects on the wetland and its vegetation communities to determine if this will be an acceptable practice.

Appropriate buffers need to be maintained around the wetland to provide habitat for marshbirds that use adjacent upland habitat at some time of their life cycle.

Grading for fairways, tees, and greens should ensure that they do not alter the surface watershed of the wetland. Drainage from these areas should never be directly into the wetland, as this is likely to introduce fertilizers and pesticides into the wetland. Appropriate buffers around the wetland need to be maintained to minimize the amounts of these chemicals that reach the wetland. Buffer requirements need to take into account the needs of waterbirds that may use the adjacent upland habitats for portions of their life cycle.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Sand and gravel pits and stone quarries are unlikely to be developed within marsh habitat. Development of pits and quarries adjacent to marshes has the potential to have effects on wetland habitat. The hydrology of the wetland may be affected if the pit or quarry is within the surface water drainage area of the wetland, if dewatering water is directed toward the wetland, or if the water table declines as a result of extraction below the water table.

Any changes in the hydrological or hydro-geological regime of the wetland can result in changes in the distribution and composition of aquatic plants within the wetland. Depending upon whether the wetland becomes wetter or drier, it may become more open or become more densely vegetated with emergent vegetation. If water is pumped from the pit or quarry into the wetland basin, this may alter the natural hydro-period and promote establishment of non-native species such as purple loosestrife and reed grass.

Also, some species are sensitive to human disturbance. If human activity increases in and adjacent to the marsh, some bird species may abandon the area.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC ecosite is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

If the pit or quarry is within the watershed of the marsh and will intercept surface water flow that would normally feed into the wetland, the impacts of this should first be predicted. It needs to be determined what effects this will have on the wetland and its resultant vegetation communities. If it is likely that adverse impacts will occur, then another source of water for the wetland should be provided, possibly through pumping.

If water is pumped into the wetland, discharge water should first be directed to a settling pond to remove sediments and excess nutrients. Discharge to the wetland should be such that it matches conditions prior to extraction so that normal water levels and hydro periods within the wetland are maintained.

A hydro-geological study should be undertaken to determine if groundwater flow to the wetland will be altered and if there will be significant effects on the wetland. If it is determined that there will be impacts if no mitigation is undertaken, then methods of maintaining the water table within the wetland should be investigated. These may include installing an impervious barrier around the pit or quarry so that dewatering does not affect adjacent lands, or pumping of water. Although these mitigation measures have been proposed for a number of quarries, their efficacy has yet to be tested.

For aggregate or mine development on lands adjacent to marsh bird breeding habitat, schedule construction to occur in the fall or winter, when marsh birds are not nesting in the habitat. To mitigate some of the impacts related to human disturbance, consider installing fencing around the development to keep people and machinery off the habitat. If fencing is used, it is very important to ensure that it does not block wildlife movement to/from the habitat. Leave a visual barrier of natural vegetation between the fence and the habitat. These measures may help reduce disturbance impacts related to human activity on the development. Additionally, signage and a public education campaign may help workers understand the unique characteristics of the marsh, and the value of leaving it undisturbed.

It may also be possible, over time, to rehabilitate exhausted pits and quarries to habitat suitable for marsh bird nesting. Adjacent retained habitat will provide an appropriate seed source. Where extraction has occurred below the water table, rehabilitation can include creation of wetland. There are numerous examples in Ontario of native ecosystems in abandoned pit and quarry sites, including wet meadow, marsh, fen, and shrub swamp (Browning and Tan 2002).

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Wind energy projects have the potential to adversely affect birds through direct fatalities, disturbance, and habitat loss (Kingsley and Whittam 2005; Environment Canada 2007a). With a few important exceptions (e.g., raptors in California), avian fatalities at wind power facilities tend to be low relative to other anthropogenic mortality factors (Kingsley and Whittam 2005). Collisions occur mainly at sites where there are unusual concentrations of birds (e.g., migration corridors) and wind turbines, or where the behaviour of birds puts them at risk (e.g., aerial courtship displaying) (Arcus Renewable Energy Consulting Ltd. 2007).

Greater adverse effects from wind power facility development result from habitat loss and disturbance (Kingsley and Whittam 2005).

Shoreline and offshore areas are attractive locations for wind power facilities due to the frequency and velocity of winds. Islands and shorelines represent important habitat for large populations of birds. There is potential for wind power facilities to be constructed in the lower Great Lakes. Construction of turbines, turbine pads and access roads in nearshore marsh habitat would require large-scale site alterations that would destroy the habitat. Draining, dredging, excavation or filling of wetland habitat to establish development will have negative impacts on both the feature and its ecological function as a nesting area for marshland birds.

It is important that marshes remain as large as possible. Loss of wetland area will result in there being fewer feeding and nesting areas for birds, or the remnant wetland may not be large enough to support area-sensitive species. The remnant wetland is also likely to be deeper than the original wetland, as the smaller basin will still have to hold the same amount of water. This is likely to change the ratio of open water to emergent vegetation in the wetland and thereby affect its suitability for certain species.

Changes to water levels as a result of development will affect distribution of emergent vegetation and, therefore, habitat for marsh-nesting birds. Cattails and other marsh plants are sensitive to water-level fluctuations and depths. As water levels change, so does the density of cattails and other vegetation. As water levels increase, the amount of emergent vegetation declines and the ratio of emergent vegetation to open water decreases. If water levels increase during the nesting season, nests situated near the water's surface may be flooded. As water levels decline, the area of emergents increases as does the ratio of emergents to open water. Lower water levels may expose some nests that were initially built over shallow water, making them more vulnerable to predators, and the lack of open water may discourage some bird species from nesting. If water levels fluctuate more than is normal, this may flood or expose nests. Abnormal water-level fluctuations also stress aquatic plant communities and may favour invasion by species such as purple loosestrife or reed grass. Because marsh birds have specific nest site vegetation density requirements, they will abandon sites when vegetation cover becomes too sparse or too dense. If significant areas of marshland vegetation are affected, then alternate nesting sites within the marsh may not exist. As a consequence, the marsh may cease to function as nesting habitat for certain bird species of conservation concern.

Development on adjacent lands may also have major effects on nesting birds owing to impacts on marsh water levels or degradation of water quality. Discharge of sediments or high nutrient loadings to wetlands can affect the distribution of aquatic plants. Increased turbidity due to sediments or algae blooms decreases the depth that sunlight can penetrate the water in the wetland. This decreases the area that is capable of supporting submergent vegetation. As turbidity increases, the plant and aquatic invertebrate communities become simplified and dominated by pollution-tolerant species. In extreme cases, the wetland may fill in prematurely.

Adjacent upland areas may be used by some of these species for foraging or even nesting, such as the American Bittern and Virginia Rail. Development of adjacent areas may reduce the attractiveness of the marsh to these species.

Turbine noise, the physical movement of turbines during operation, and human activities associated with turbine maintenance may disturb nesting birds. If human activity increases in and adjacent to the marsh, some bird species may abandon the area. The species most sensitive to human disturbance, in approximate decreasing order, are Sandhill Crane, Red-necked Grebe (although it has adapted to human use on Lake Ontario and in many areas in the northwest where it nests adjacent to marinas and boat launches on lakes with cottages), American Bittern, American Coot, Common Moorhen (at least formerly, but the species has seriously declined in Ontario), and Little Gull.

Mitigation Options: Wind Power Facilities

No renewable energy project may be developed within or expanded into a significant waterfowl staging area in a provincially significant southern or coastal wetland (O.Reg. 37.1 and 37.2). The siting of wind turbines within 120 m of the outer edge of any ELC ecosite that contains waterfowl staging SWH in a provincially significant northern wetland or elsewhere should be avoided. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. The area of the ELC ecosite is the SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on waterfowl staging habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing, dredging, excavation and filling for development in marsh bird breeding SWH will destroy the affected habitat; the ecological function of the remaining habitat for nesting will be reduced or lost if the development alters the hydrology of the marsh. Human disturbance associated with the development will further reduce the habitat's ecological function. The best mitigation option is to avoid developing in the habitat. In some cases, habitat may be protected under the provincial wetland policy.

When complete avoidance of the habitat is not possible, and the SWH is very large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; 2) placing it at an edge; and 3) placing it where nest density is lowest. Edge placement will maximize the amount of undisturbed habitat and minimize the barrier effect for species nesting in upland areas adjacent to the habitat. The retained marsh area must be large enough to support the most area-sensitive species present.

Schedule construction and regular maintenance to occur in the fall or winter, when waterfowl are not nesting in the habitat. Leave a visual barrier of natural vegetation between the development and the habitat to reduce the effects of human disturbance on nesting birds. Ensure that the construction process does not introduce sediment into the habitat, and keep equipment and machinery off the habitat that is to be retained. Signage and a public education campaign may help workers understand the unique characteristics of waterfowl nesting habitat, and the value of leaving it undisturbed.

Even with these mitigation measures in place, developing within marsh bird breeding habitat (even when it is very large) will damage the feature and reduce its ecological function. It may be possible to at least partly compensate for these losses by enhancing or expanding the retained wetland. However, this type of mitigation should never be planned as a trade-off for destroying some of the original wetland. Proponents wishing to enhance wetland functions or size should refer to the Temperate Wetland Restoration Guidelines (Mansell et al. 1998).

Potential Development Effects: Solar Power Facilities

Draining, dredging, excavation, or filling portions of wetlands to establish development will have negative impacts on the both the feature and its ecological function as a nesting area for marshland birds.

Changes to water levels as a result of development will affect distribution of emergent vegetation and, therefore, habitat for marsh-nesting birds. Cattails and other marsh plants are sensitive to water-level fluctuations and depths. As water levels change, so does the density of cattails and other vegetation. As water levels increase, the amount of emergent vegetation declines and the ratio of emergent vegetation to open water decreases. If water levels increase during the nesting season, nests situated near the water's surface may be flooded. As water levels decline, the area of emergents increases as does the ratio of emergents to open water. Lower water levels may expose some nests that were initially built over shallow water, making them more vulnerable to predators, and the lack of open water may discourage some bird species from nesting. If water levels fluctuate more than is normal, this may flood or expose nests. Abnormal water-level fluctuations also stress aquatic plant communities and may favour invasion by species such as purple loosestrife or reed grass. Because marsh birds have specific nest site vegetation density requirements, they will abandon sites when vegetation cover becomes too sparse or too dense. If significant areas of marshland vegetation are affected, then alternate nesting sites within the marsh may not exist. As a consequence, the marsh may cease to function as nesting habitat for certain bird species of conservation concern.

It is important that marshes remain as large as possible. Loss of wetland area will result in there being fewer feeding and nesting areas for birds, or the remnant wetland may not be large enough to support area-sensitive species. The remnant wetland is also likely to be deeper than the original wetland, as the smaller basin will still have to hold the same amount of water. This is likely to change the ratio of open water to emergent vegetation in the wetland and thereby affect its suitability for certain species.

Development on adjacent lands may have major effects on nesting birds owing to impacts on marsh water levels or degradation of water quality. Discharge of sediments or high nutrient loadings to wetlands can affect the distribution of aquatic plants. Increased turbidity due to sediments or algae blooms decreases the depth that sunlight can penetrate the water in the wetland. This decreases the area that is capable of supporting submergent vegetation. As turbidity increases, the plant and aquatic invertebrate communities become simplified and dominated by pollution-tolerant species. In extreme cases, the wetland may fill in prematurely.

Adjacent upland areas may be used by some of these species for foraging or even nesting, such as the American Bittern and Virginia Rail. Development of adjacent areas may reduce the attractiveness of the marsh to these species.

Also, some species are sensitive to human disturbance. If human activity increases in and adjacent to the marsh, some bird species may abandon the area. The species most sensitive to human disturbance, in approximate decreasing order, are Sandhill Crane, Red-necked Grebe (although it has adapted to human use on Lake Ontario and in many areas in the northwest where it nests adjacent to marinas and boat launches on lakes with cottages), American Bittern, American Coot, Common Moorhen (at least formerly, but the species has seriously declined in Ontario), and Little Gull.

Mitigation Options: Solar Power Facilities

No renewable energy project may be developed within or expanded into a significant waterfowl staging area in a provincially significant southern or coastal wetland (O.Reg. 37.1 and 37.2). The siting of solar panel arrays within 120 m of the outer edge of any ELC ecosite that contains waterfowl staging SWH in a provincially significant northern wetland or elsewhere should be avoided. The area of the ELC ecosite is the SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing, dredging and filling for development in marsh bird breeding SWH will destroy the affected habitat; the ecological function of the remaining habitat for nesting will be reduced or lost if the development alters the hydrology of the marsh. Human disturbance associated with the development will further reduce the habitat's ecological function. The best mitigation option is to avoid developing in the habitat. In some cases, habitat may be protected under the provincial wetland policy.

When complete avoidance of the habitat is not possible, and the SWH is very large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; 2) placing it at an edge; and 3) placing it where nest density is lowest. Edge placement will maximize the amount of undisturbed habitat. The retained marsh area must be large enough to support the most area-sensitive species present. Implement sediment and contaminant controls during construction to prevent impacts to the retained marsh habitat.

Schedule construction and, to the extent possible, regular maintenance activities to occur in the fall or winter, when marsh birds are not nesting in the habitat. To mitigate some of the impacts related to human disturbance, consider installing fencing around the development to keep workers and machinery off the habitat. If fencing is used, it is very important to ensure that it does not block wildlife movement to/from the habitat. Leave a visual barrier of natural vegetation between the fence and the habitat. These measures may help reduce disturbance impacts related to human activity on the development. Additionally, signage and a public education campaign may help people understand the unique characteristics of the marsh, and the value of leaving it undisturbed.

Even with these mitigation measures in place, developing within marsh bird breeding habitat (even when it is very large) will damage the feature and reduce its ecological function. It may be possible to at least partly compensate for these losses by enhancing or expanding the retained wetland. However, this type of mitigation should never be planned as a trade-off for destroying some of the original wetland. Proponents wishing to enhance wetland functions or size should refer to the Temperate Wetland Restoration Guidelines (Mansell et al. 1998).

Development within a wetland will greatly affect hydrology and therefore plant communities within the wetland. Development will reduce the storage area of the wetland. If the same watershed is maintained, water levels are likely to increase, thereby reducing the extent of vegetation within the marsh. A water balance study should be conducted for any development within a wetland.

Adjacent land development can be benign provided care is taken to ensure that water levels and water quality in the marsh do not change. Hydrological studies will be required to predict changes in water levels and the duration, magnitude, and frequency of water-level fluctuations. If the wetland receives groundwater inputs, it should be demonstrated that development will not alter the amount of groundwater reaching the wetland. Appropriate stormwater management will be required to ensure that an excess of sediments or nutrients does not reach the wetland. For large-scale developments, a water and nutrient balance may be required to demonstrate that there will be no impact on wetland functions.

ROAD DEVELOPMENT

Potential Development Effects

Roads constructed through marshes may have detrimental effects on the wetland and waterbirds. The footprint of the wetland will be a direct loss of habitat and it may represent a barrier to movement of birds within the wetland.

Bogner and Baldassarre (2002) radio-tracked Least Bitterns in New York and found that most birds were reluctant to move even across berms separating wetlands. Those that did were mostly females that were in search of males that were in the best home ranges. Thus a road may inhibit movement of birds between different areas of the marsh. In addition, certain waterbird species, such as rails and bitterns, are susceptible to being killed by vehicles on roads.

Roads in or adjacent to a marsh may result in increased sediments and contaminants being introduced into the wetland. This may change the composition and distribution of emergent and submergent aquatic vegetation in the wetland. If the water becomes more turbid, growth of submergent vegetation will be inhibited and higher nutrient concentrations may favour growth of monotypic stands of cattails or invasion by non-native species.

Roads may also act as an impermeable barrier, damming water on the upstream side. This may result in drying of marshes where roads are outside of the wetland, or in increased water levels in one part of the marsh and lowered water levels in the other where roads are in marshes. Changes in water levels will change the distribution of emergent vegetation and affect the vegetation to open water ratio.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the ELC ecosite is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing, dredging and filling for road construction in marsh bird breeding SWH will destroy the affected habitat, and beyond if the hydrology of the marsh is altered. The best mitigation option is to avoid developing in the habitat. Where complete avoidance is not possible, route the road along the edge of the habitat instead of bisecting it.

For roads that pass through a marsh, sufficient culverts are to be installed to allow water-level stabilization between the two halves of the wetland. Oversize box culverts should be installed in shallower areas that support emergent vegetation and this may allow movement of certain species of waterbirds under the road. In some cases, a raised road may be preferable to a causeway type road. These types of roads, however, are significantly more expensive than causeways and it may be less expensive to change the route of the road to avoid the wetland or only infringe on the edge of it.

Speed limits should be reduced on roads where they traverse marsh habitat to reduce the incidence of road kill.

Even for roads that are not directly in the wetland, sufficient culverts should be installed to allow for the normal passage of water to the wetland.

Depending on the nature of the wetland and its sensitivity, runoff from the road should not be allowed to run directly into the wetland. Stormwater detention areas should be installed to intercept water and allow it to settle prior to discharge to the wetland. For roads within or immediately adjacent to the wetland, thought should be given to installing splash guards along the edge of the road. These are Plexiglas barriers that attach to the railings and help reduce salt spray and introduction of other contaminants. If these types of barriers are planned, there should be adequate room under the road to allow wildlife movement from one side of the marsh to the other.

INDEX #36: TERRESTRIAL CRAYFISH HABITAT

Ecoregions:	6E, 7E
Species Group:	Chimney or Digger Crayfish (Fallicambarus fodiens), Meadow Crayfish or Devil Crawfish (Cambarus diogenes)
Significant Wildlife Habitat Category:	Habitat of Species of Conservation Concern
Functional Habitat:	Wet meadows and edges of wetlands

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

In Ontario, there are two species of crayfish that are semi-terrestrial and that are primary or secondary burrowers. These are the Meadow Crayfish (or Devil Crawfish) (Cambarus diogenes) and the Chimney or Digger Crayfish (Fallicambarus fodiens). These species spend most of their time within burrows that consist of a series of underground tunnels, but they leave the burrows at night to feed. They appear to be obligate burrowers in Ontario (Guiasu et al. 1996).

The Meadow Crayfish typically constructs colonies of burrows in wet meadows and marshes. Areas used typically have standing water at least in the spring. In the United States, burrows may also occur near permanent surface waters such as spring-fed pools, artesian wells, and marsh and farm ponds, but they may also burrow far from surface water of any kind (Crocker and Barr 1968). In early spring during the breeding season, adults are often found in streams, lakes, and rivers (Crocker and Barr 1968). Terrestrial vascular plants appear to be important in its diet and individuals leave the burrow at night to forage. The Meadow Crayfish is the rarest Ontario crayfish, being restricted to extreme southwestern Ontario, except for a single record from Atikokan (Crocker and Barr 1968). In that there appears to be considerable suitable habitat farther north than its current range, its distribution may be restricted by climate (Crocker and Barr 1968). The total range of the Meadow Crayfish in southern Ontario covers an area of about 4,500 km2, an area about 300 km long (from Point Pelee to Wainfleet) but only 10 to 30 km wide (Guiasu et al. 1996).

The Chimney Crayfish is usually associated with marshy fields, drainage ditches, marshes, and ponds. The burrows are usually constructed in clay soil, which may also contain varying proportions of sand or coarse gravel. Colonies may be a few square metres in area with 10 to 20 chimneys, or be as large as 0.4 ha (Crocker and Barr 1968). The Chimney Crayfish may occur in woodland ponds and even in temporary streams (Williams et al. 1974).

See the Appendix of species descriptions for details about the burrows of these two crayfish species.

Potential Development Effects and Mitigation Options

Development within habitat for the Meadow and Chimney Crayfish will result in direct loss of their habitat and possibly extirpation of the local population. Some of the local populations reported by Crocker and Barr (1968) have since been developed and no longer support burrowing crayfish (Guiasu et al. 1996).

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Large-scale site alteration in terrestrial crayfish habitat may result in loss of the habitat. Excavation and filling where there are burrows will physically destroy the burrows and associated tunnels used by terrestrial crayfish. Heavy machinery may cause sufficient soil compression to damage or destroy burrows and subterranean tunnels. Additionally, where development alters the habitat's hydrology, ecological function may be reduced or lost.

Surface water that is directed toward crayfish habitat has the potential to have adverse effects as this may result in flooding of burrows, unstable water levels within burrows and introduction of contaminants into the crayfish habitat (e.g., urban and industrial pollution, road runoff). Additionally, surface water has the potential to introduce sediments into crayfish habitat. If the clay and silty-clay soils that they require become covered with other sediments, the soils may not be suitable for burrowing or constructing chimneys.

Although limited data are available, it appears that both species of these crayfish feed primarily on terrestrial vascular plants (Guiasu et al. 1996). Development activities that clear and/or remove plants within or immediately adjacent to crayfish habitat may affect their food supply.

Development on adjacent land also has the potential to affect populations of burrowing crayfish. Activities that result in a change in the water table (drainage works, flow diversions, piping watercourses, etc.) may either result in flooding of burrows or making the soils too dry to support crayfish. Higher water tables may result in asphyxiation of crayfish if the burrow becomes filled with water too near the surface. Crayfish may also be forced to move to adjacent areas where the water table is lower to obtain the correct mix of air and water within the burrow. If the water table declines or if areas are drained/dewatered, the soil may become too hard and dry for the crayfish to burrow in it, or they may have to burrow an excessive depth to reach water.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The ELC ecosite that contains the terrestrial crayfish burrow(s) is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing, excavation, draining and filling for development in terrestrial crayfish habitat will destroy the affected habitat. The ecological function of the remaining habitat will be reduced or lost if the development alters the hydrology of the habitat, or if compression of the soil damages or destroys burrows or subterranean tunnels. The best mitigation option is to avoid developing in the habitat.

When complete avoidance of the habitat is not possible, and the SWH is large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; and 2) placing it at an edge as far from any burrow sites as possible. When planning the development, avoid siting it where it will block crayfish travelling between burrows and temporary or permanent wet areas of the habitat. These measures will maximize the amount of undisturbed habitat, and reduce the barrier effect. Because terrestrial crayfish appear to be colonial, often occupying only a small proportion of the available habitat, it should be possible to avoid areas supporting crayfish.

A water balance study needs to be undertaken to ensure that there will be no measurable change in the water table level or in surface water quality or quantity. Drainage of wet meadows and marshy wetlands should always be avoided.

Vegetation should never be removed immediately adjacent to crayfish habitat, as this is important forage.

Surface water runoff needs to be directed away from potential crayfish burrows to avoid sedimentation that adversely affects the crayfish's ability to dig burrows. Maintenance of drainage ditches (e.g., clearing of ditches) should be scheduled for periods when the crayfish are less likely to be present (e.g., early spring, when adults are often found in streams, lakes, and rivers) (Crocker and Barr 1968).

Public awareness about the presence of burrowing crayfish and the importance of maintaining their habitat is also an important conservation strategy.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Marinas and golf courses are the types of major recreational development that are most likely to affect habitat of terrestrial crayfish.

Large-scale site alteration in terrestrial crayfish habitat may result in loss of the habitat. Excavation, filling and grading where there are burrows will physically destroy the burrows and associated tunnels used by terrestrial crayfish. Heavy machinery may cause sufficient soil compression to damage or destroy burrows and subterranean tunnels. Additionally, where development alters the habitat's hydrology, ecological function may be reduced or lost.

Surface water that is directed toward crayfish habitat has the potential to have adverse effects as this may result in flooding of burrows, unstable water levels within burrows and introduction of contaminants into the crayfish habitat (e.g., urban, agricultural and industrial pollution, road runoff). Additionally, surface water has the potential to introduce sediments into crayfish habitat. If the clay and silty clay soils that they require become covered with other sediments, the soils may not be suitable for burrowing or constructing chimneys.

Although limited data are available, it appears that both species of these crayfish feed primarily on terrestrial vascular plants (Guiasu et al. 1996). Development activities that clear and/or remove plants within or immediately adjacent to crayfish habitat may affect their food supply.

Development on adjacent land also has the potential to affect populations of burrowing crayfish. Activities that result in a change in the water table may either result in flooding of burrows or making the soils too dry to support crayfish. Higher water tables may result in asphyxiation of crayfish if the burrow becomes filled with water too near the surface. Crayfish may also be forced to move to adjacent areas where the water table is lower to obtain the correct mix of air and water within the burrow. If the water table declines or if areas are drained/dewatered, the soil may become too hard and dry for the crayfish to burrow in it, or they may have to burrow an excessive depth to reach water.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The ELC ecosite that contains the terrestrial crayfish burrow(s) is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing, excavation, draining and filling for development in terrestrial crayfish habitat will destroy the affected habitat. The ecological function of the remaining habitat will be reduced or lost if the development alters the hydrology of the habitat, or if compression of the soil damages or destroys burrows or subterranean tunnels. The best mitigation option is to avoid developing in the habitat.

When complete avoidance of the habitat is not possible, and the SWH is large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; and 2) placing it at an edge as far from any burrow sites as possible. When planning the development, avoid siting it where it will block crayfish travelling between burrows and temporary or permanent wet areas of the habitat. These measures will maximize the amount of undisturbed habitat, and reduce the barrier effect. Because terrestrial crayfish appear to be colonial, often occupying only a small proportion of the available habitat, it should be possible to avoid areas supporting crayfish.

A water balance study needs to be undertaken to ensure that there will be no measurable change in the water table level or in surface water quality or quantity. Drainage of wet meadows and marshy wetlands should always be avoided.

Vegetation should never be removed immediately adjacent to crayfish habitat, as this is important forage. On golf courses, spraying of pesticides and fertilizers should never occur in areas near crayfish habitat, as this has the potential to affect their food supply.

Surface water runoff should always be directed away from potential crayfish burrows to avoid sedimentation that adversely affects the crayfish's ability to dig burrows. Maintenance of drainage ditches (e.g., clearing of ditches) should be scheduled for periods when the crayfish are less likely to be present (e.g., early spring, when adults are often found in streams, lakes, and rivers) (Crocker and Barr 1968).

Public awareness about the presence of burrowing crayfish and the importance of maintaining their habitat is also an important conservation strategy.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Removal of clay for bricks and other products has the potential to occur directly within habitat for terrestrial crayfish. Clay removal may also result in a lowering of the water table and consequent drying of adjacent habitat that supports crayfish. This may make the area too dry to be suitable for burrow construction, or the water table may be too deep for the crayfish to access it.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The ELC ecosite that contains the terrestrial crayfish burrow(s) is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing, excavation, draining and filling for development in terrestrial crayfish habitat will destroy the affected habitat. The ecological function of the remaining habitat will be reduced or lost if the development alters the hydrology of the habitat, or if compression of the soil damages or destroys burrows or subterranean tunnels. The best mitigation option is to avoid developing in the habitat.

When complete avoidance of the habitat is not possible, and the SWH is large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; and 2) placing it at an edge as far from any burrow sites as possible. When planning the development, avoid siting it where it will block crayfish travelling between burrows and temporary or permanent wet areas of the habitat. These measures will maximize the amount of undisturbed habitat, and reduce the barrier effect. Because terrestrial crayfish appear to be colonial, often occupying only a small proportion of the available habitat, it should be possible to avoid areas supporting crayfish.

Mining of clay has a greater potential to affect crayfish, as moist clay is a primary habitat requirement for these species. Ontario's two species of terrestrial crayfish appear to be somewhat colonial, occupying small areas within large areas of potentially suitable habitat. Inventories should be undertaken prior to mining to determine areas that support crayfish. These areas should be retained if at all possible.

A hydro-geological study should be undertaken to determine if clay mining will affect the water table level where the crayfish habitat is located. If the water table has the potential to be adversely affected, mitigation will be required to maintain appropriate water levels. This may entail limiting the depth of extraction, creating an impermeable barrier so that the crayfish habitat is not affected by dewatering activities, or by pumping water at appropriate rates to the crayfish habitat.

Water from dewatering activities should always be directed away from potential crayfish burrows to avoid sedimentation that adversely affects the crayfish's ability to dig burrows. There may, however, be circumstances where it is beneficial to direct water toward crayfish habitat to maintain the water balance. In these cases, the water should be directed to sediment ponds before it flows into the crayfish habitat.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

There is the potential that wind power facilities could be constructed in damp meadows that support terrestrial crayfish. Permanent access roads and pads for turbines can result in loss of habitat. Compaction of soil by heavy equipment may destroy existing burrows/tunnels, or make the substrate less suitable for burrowing new tunnels. Access roads may also affect drainage patterns and suitability of areas adjacent to the roads for burrowing by crayfish.

Mitigation Options; Wind power facilities

The siting of wind turbines within 120 m of the edge of terrestrial crayfish SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. The ELC ecosite that contains the terrestrial crayfish burrow(s) is the SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function. The ELC ecosite that contains the terrestrial crayfish burrow(s) is the SWH.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing, excavation, draining and filling for development in terrestrial crayfish habitat will destroy the affected habitat. The ecological function of the remaining habitat will be reduced or lost if the development alters the hydrology of the habitat, or if compression of the soil damages or destroys burrows or subterranean tunnels. The best mitigation option is to avoid developing in the habitat.

When complete avoidance of the habitat is not possible, and the SWH is large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; and 2) placing it at an edge as far from any burrow sites as possible. When planning the development, avoid siting turbines where they will block crayfish travelling between burrows and temporary or permanent wet areas of the habitat. These measures will maximize the amount of undisturbed habitat, and reduce the barrier effect. Because terrestrial crayfish appear to be colonial, often occupying only a small proportion of the available habitat, it should be possible to avoid areas supporting crayfish.

When planning the development, avoid siting it where it will block crayfish travelling between burrows and temporary or permanent wet areas of the habitat. Prior to construction, areas that support crayfish need to be fenced off so that they are not damaged by equipment.

Sufficient culverts should be installed under access roads to ensure that natural drainage patterns are maintained.

Potential Development Effects: Solar Power Facilities

Large-scale site alteration in terrestrial crayfish habitat may result in loss of the habitat. Vegetation clearing, drainage, filling etc. where there are burrows will physically destroy the burrows and associated tunnels used by terrestrial crayfish. Heavy machinery may cause sufficient soil compression to damage or destroy burrows and subterranean tunnels. Additionally, where development alters the habitat's hydrology, ecological function may be reduced or lost.

Surface water that is directed toward crayfish habitat has the potential to have adverse effects as this may result in flooding of burrows, unstable water levels within burrows and introduction of contaminants into the crayfish habitat (e.g., contaminated runoff from solar panels and access roads). Additionally, surface water has the potential to introduce sediments into crayfish habitat. If the clay and silty-clay soils that they require become covered with other sediments, the soils may not be suitable for burrowing or constructing chimneys.

Although limited data are available, it appears that both species of these crayfish feed primarily on terrestrial vascular plants (Guiasu et al. 1996). Development activities that clear and/or remove plants within or immediately adjacent to crayfish habitat may affect their food supply.

Development on adjacent land also has the potential to affect populations of burrowing crayfish. Activities that result in a change in the water table (drainage works, flow diversions, piping watercourses, etc.) may either result in flooding of burrows or making the soils too dry to support crayfish. Higher water tables may result in asphyxiation of crayfish if the burrow becomes filled with water too near the surface. Crayfish may also be forced to move to adjacent areas where the water table is lower to obtain the correct mix of air and water within the burrow. If the water table declines or if areas are drained/dewatered, the soil may become too hard and dry for the crayfish to burrow in it, or they may have to burrow an excessive depth to reach water.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of the edge of terrestrial crayfish SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The ELC ecosite that contains the terrestrial crayfish burrow(s) is the SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function. The ELC ecosite that contains the terrestrial crayfish burrow(s) is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing, drainage, filling and other site alterations for development in terrestrial crayfish habitat will destroy the affected habitat. The ecological function of the remaining habitat will be reduced or lost if the development alters the hydrology of the habitat, or if compression of the soil damages or destroys burrows or subterranean tunnels. The best mitigation option is to avoid developing in the habitat.

When complete avoidance of the habitat is not possible, and the SWH is large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; and 2) placing it at an edge as far from any burrow sites as possible. When planning the development, avoid siting it where it will block crayfish travelling between burrows and temporary or permanent wet areas of the habitat. These measures will maximize the amount of undisturbed habitat, and reduce the barrier effect. Because terrestrial crayfish appear to be colonial, often occupying only a small proportion of the available habitat, it should be possible to avoid areas supporting crayfish.

A water balance study needs to be undertaken to ensure that there will be no measurable change in the water table level or in surface water quality or quantity. Drainage of wet meadows and marshy wetlands should always be avoided.

Vegetation should never be removed immediately adjacent to crayfish habitat, as this is important forage.

Surface water runoff needs to be directed away from potential crayfish burrows to avoid sedimentation that adversely affects the crayfish's ability to dig burrows. Maintenance of drainage ditches (e.g., clearing of ditches) should be scheduled for periods when the crayfish are less likely to be present (e.g., early spring, when adults are often found in streams, lakes, and rivers) (Crocker and Barr 1968).

Public awareness about the presence of burrowing crayfish and the importance of maintaining their habitat is also an important conservation strategy.

ROAD DEVELOPMENT

Potential Development Effects

The development of roads in terrestrial crayfish habitat may result in its loss.

Surface water from roads that is directed toward crayfish habitat has the potential to have adverse effects as this may result in flooding of burrows, unstable water levels within burrows and introduction of contaminants into the crayfish habitat. Additionally, surface water has the potential to introduce sediments into crayfish habitat. If the clay and silty clay soils that they require become covered with other sediments, the soils may not be suitable for burrowing or constructing chimneys.

Roads may act as a barrier to surface water and shallow groundwater movement. This results in wetter conditions on one side of the road and drier conditions on the other. This may either result in flooding of burrows or making the soils too dry to support crayfish. Higher water tables may result in asphyxiation of crayfish if the burrow becomes filled with water to near the surface. Crayfish may also be forced to move to adjacent areas where the water table is lower to obtain the correct mix of air and water within the burrow. If the water table declines or if areas are drained/dewatered, the soil may become too hard and dry for the crayfish to burrow in it, or they may have to burrow an excessive depth to reach water.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The ELC ecosite that contains the terrestrial crayfish burrow(s) is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing, excavation, draining and filling for development in terrestrial crayfish habitat will destroy the affected habitat. The ecological function of the remaining habitat will be reduced or lost if the development alters the hydrology of the habitat, or if compression of the soil damages or destroys burrows or subterranean tunnels. The best mitigation option is to avoid developing in the habitat.

When complete avoidance of the habitat is not possible, and the SWH is large, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; and 2) placing it at an edge as far from any burrow sites as possible. When planning the development, avoid siting roads where they will block crayfish travelling between burrows and temporary or permanent wet areas of the habitat. These measures will maximize the amount of undisturbed habitat, and reduce the barrier effect. Because terrestrial crayfish appear to be colonial, often occupying only a small proportion of the available habitat, it should be possible to avoid areas supporting crayfish.

Vegetation should never be removed immediately adjacent to crayfish habitat, as this is important forage. Spraying of pesticides to control roadside vegetation should be avoided in areas near crayfish habitat, as this has the potential to affect the crayfish food supply. Consideration should be given to using de-icing compounds other than salt near the habitat.

Roadside ditches should be designed so that they do not drain crayfish burrows or dry up the soils where burrows are located.

Surface water runoff should always be directed away from crayfish habitat to avoid sedimentation that adversely affects the crayfish's ability to dig burrows. It may be necessary to construct stormwater management ponds if surface runoff is likely to run directly into crayfish habitat. Maintenance of ditches should be scheduled for periods when the crayfish are less likely to be present (e.g., early spring, when adults are often found in streams, lakes, and rivers) (Crocker and Barr 1968).

Sufficient culverts should be installed under the road to ensure unimpeded movement of surface water and groundwater.

INDEX #37: SPECIAL CONCERN, S1, S2 AND S3 SPECIES HABITAT

Ecoregions:	All of Ontario
Species Group:	
	All Special Concern and Rare (S1, S2, S3) plant and animal species or
communities	
Significant Wildlife Habitat Category:	Habitat of Species of Conservation Concern
Functional Habitat:	Preferred Habitat

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Special Concern species, and species of provincial conservation concern, represent a very broad group, so it is difficult to identify general habitat functions and composition. The treatment of plants and animals is somewhat different - plants are relatively restricted in their movements while animals may be more wide-ranging.

For plant species, the critical habitat may be the Ecological Land Classification (ELC) unit in which the species occurs. When dealing with a Special Concern or rare plant species, the ELC unit must be defined in much greater detail than is frequently done for an Impact Assessment. A literature search should be prepared for the species in question to determine its microhabitat requirements prior to defining its habitat in the field. The ELC unit should be defined using these microhabitat requirements. Therefore, the ELC unit will be defined not only by the general vegetation community, but also by more detailed parameters such as soil type and drainage, slope and aspect, canopy closure (in forested habitats), shrub layer, ground flora, and associated plant species.

When defining the habitat for a special concern or rare plant species, it is not enough to simply save the area where the plant occurs. The full life history of the species must be understood so that it has suitable area to reproduce and maintain a population. In addition to the microhabitats used to define the ELC unit that is critical to the species, external influences must be considered. For instance, if the plant is a forest species, removal of adjacent forest may change some of the microclimate features upon which the species depends.

When dealing with a special concern or S1, S2 or S3 species, it is important to understand the factors responsible for the species being designated rare or of concern. There may be one period of the species' life history that is particularly critical, while other times (and the habitats that are used then) may not be overly important to the species. For instance, breeding habitat is most critical for passerine birds whereas migration habitat may not be overly important except for key stopover areas. In the case of a dragonfly, it may be the aquatic habitat required by nymphs that is critical, while foraging habitat for the adult may not be as important. For less mobile species such as amphibians and reptiles, breeding, summer, and winter habitat are all critical, as are corridors that connect these habitats.

Regardless of what species is of concern, the Impact Assessment needs to demonstrate a clear understanding of its habitat requirements during all seasons when it is present on the site that is being examined.

Process for Listing Species as Special Concern

Special Concern species may be rare or declining in the province (e.g. Common Nighthawk, Canada Warbler), or they may be more common species that have some significant limiting factors that put them at risk. Examples of special concern species that are relatively common include the Bald Eagle and the Monarch butterfly. For both of these species, there are factors other than their abundance which make them vulnerable to population declines.

In Ontario, species that may be at risk are reviewed by a team of experts known as the Committee on the Status of Species at Risk in Ontario (COSSARO). COSSARO is a legally recognized committee consisting of up to 11 people, typically with scientific expertise or Aboriginal Traditional Knowledge, from both the public and private sectors.

After careful consideration of the best available scientific and community information, and aboriginal traditional knowledge, COSSARO classifies species according to their degree of risk. Species classified as "at risk" (e.g., extirpated, endangered, threatened, special concern) are placed on the Species at Risk in Ontario (SARO) list. Species may also be classified as "not at risk" or "data deficient"; this last classification is used when there is insufficient information available to classify a species.

Information about Ontario's rare and "at risk" species is also collected and maintained by the Ontario Ministry of Natural Resources' Natural Heritage Information Centre (NHIC). Provincial species rankings (SRanks) indicate varying levels of relative conservation concern, and they are used by the NHIC to set protection priorities for rare species and natural communities. Some S1, S2 and S3 species are rare in the province, and their rarity puts them at risk of declining if additional pressure is brought to bear on them.

Species may be rare for a number of reasons:

1. they may be at the extreme edge of their range in Ontario;
2. they may require specialized or rare habitat;
3. they may have very large home ranges so that they are not common even when there is ample suitable habitat present;
4. the population may be concentrated in a small geographic area;
5. the population may be widely dispersed in low density over a large geographic area; or
6. they may be subject to widespread disease or human destruction.

There are also a few species that are very difficult to detect or identify, and some of these may be considered rare until more is known about their distribution and population numbers.

S1, S2 and S3 rankings are defined as follows:

S1 critically imperiled in the nation or state/province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province;

S2 imperiled in the nation or state/province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province; and

S3 vulnerable in the nation or state/province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.

Potential Development Effects and Mitigation Options

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Potential Development Effects will vary considerably depending on the species involved and the type of development that is proposed.

For plant species, development has the potential to have a variety of effects. Even if the habitat is left intact, it may become unsuitable for a number of reasons. Removal of vegetation surrounding the ELC unit in which it occurs may result in it becoming more exposed to wind and cooler temperatures; the site may also become invaded by species such as garlic mustard or buckthorn. Development or site alteration of adjacent land may also change the moisture regime and make the habitat less suitable or unsuitable for the species of conservation concern. The presence of humans may result in the species being trampled or picked.

For animal species that spend some of their life cycle in water (e.g., amphibians, dragonflies, damselflies), adjacent development may affect water quality and quantity. Some of the these species may be sensitive to excessive nutrients. If the development results in less groundwater flow to wetlands, ponds, or watercourses, certain species may not be able to complete their aquatic phase before the area dries up. Many water-dependent species are sensitive to water currents. Increased water flows as a result of development have the potential to reduce the suitability of the habitat for certain species.

For terrestrial animals, there are several potential impacts of development. Development and associated road systems may isolate species from key habitat areas that are used at different times during their life history. This is most critical for species that have both aquatic and terrestrial life phases, but also for those that move to different habitats for different seasons of the year. For area-sensitive species, the residual habitat may be too small to support a viable population. Disturbance by humans and predation by pets may also affect some species.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the habitat to the finest ELC scale that protects the habitat form and function is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

The best mitigation is to avoid affecting the habitat of Special Concern and S1, S2 and S3 species. When complete avoidance is not possible, mitigation will necessarily be site specific depending upon the nature of the development and the species involved.

For species with aquatic life-cycle phases, appropriate stormwater management will be required to ensure that water quality is not impaired and that there are no significant changes to the hydro-period. If there are species that are sensitive to flowing water, means of mitigating increased flow velocities should be investigated. These might include additional storage in stormwater management ponds or installation of baffles or other energy dissipation techniques. A water balance study will be required to determine impacts on hydro-period in wetlands and ponds that support species of conservation concern.

For terrestrial plant species, it may be possible to maintain microhabitat conditions by planting shrubs at the edge of retained vegetation communities. Areas that are intended for retention should not be physically disturbed as this may make conditions suitable for invasion by garlic mustard and other non-native plant species. As part of the stormwater management plan, the drainage area that retained communities are in should be defined. If the species of conservation concern is susceptible to changes in moisture regime, it should be demonstrated that the proposed development will not result in changes that will make the habitat unsuitable.

For terrestrial animals, it should be demonstrated that retained habitat will be capable of maintaining a viable population. This will require an assessment of the current viability of the population. Certain species may have limiting factors that are not related to habitat, so that simple retention of habitat may not suffice to ensure continued existence of the species on site. The Golden-winged Warbler is an example of such a species.

Fencing, education, and signage may be methods of controlling human activity. If fencing is used, it is very important to ensure that it does not block wildlife movement to/from the habitat. People should be encouraged to keep all pets in the area, including cats, on leashes when they are outside. Signage and a public education campaign may help people understand the unique characteristics of the habitat and the wildlife species that depend on it, and the value of leaving it undisturbed.

The PPS requires a balance such that there may be occasions when the proposed development is considered to be more in the public interest than the species of conservation concern. In these instances, thought should be given to providing habitat for the species elsewhere. This could involve creation of new habitat or transplanting into existing, unoccupied habitat. If this is being considered as a mitigation measure, it should be demonstrated that the new habitat is viable prior to the development taking place.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses, ski resorts, and marinas have the potential to affect Special Concern and S1, S2 and S3 species. These types of developments may result in direct loss of habitat to significant species or in indirect effects which degrade adjacent habitat and/or inhibit movement patterns.

Creation of open, manicured swathes for golf courses and ski runs can affect adjacent habitat by changing microclimate and introducing edge effects. These may affect moisture regimes and sunlight intensity, the distribution of non-native plant species, and predation and parasitism rates in the residual habitat.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the habitat to the finest ELC scale that protects the habitat form and function is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

The best mitigation is to avoid affecting the habitat of Special Concern and S1, S2 and S3 species. When complete avoidance is not possible, mitigation will necessarily be site specific depending upon the nature of the development and the species involved.

For species with aquatic phases, appropriate stormwater management will be required to ensure that water quality is not impaired and that there are no significant changes to the hydro-period. Runoff from parking lots and other facilities such as maintenance areas and clubhouses should be directed to stormwater management facilities if aquatic species of concern are present. In the case of golf courses, suitable buffers should be placed around significant aquatic habitat where there will be no application of fertilizers or pesticides.

If there are species that are sensitive to flowing water, means of mitigating increased flow velocities should be investigated. These might include additional storage in stormwater management ponds or installation of baffles or other energy dissipation techniques. A water balance study will be required to determine impacts on hydro-period in wetlands and ponds that support species of conservation concern.

For terrestrial plant species, it may be possible to maintain microhabitat conditions by planting shrubs at the edge of retained vegetation communities. Areas that are intended for retention should not be physically disturbed as this may make conditions suitable for invasion by garlic mustard and other non-native plant species. As part of the stormwater management plan, the drainage area that retained communities are in should be defined. If the species of conservation concern is susceptible to changes in moisture regime, it should be demonstrated that the proposed development will not result in changes that will make the habitat unsuitable.

For terrestrial animals, it should be demonstrated that retained habitat will be capable of maintaining a viable population. This will require an assessment of the current viability of the population. Certain species may have limiting factors that are not related to habitat, so that simple retention of habitat may not suffice to ensure continued existence of the species on site. The Golden-winged Warbler is an example of such a species.

Fencing, education, and signage may be methods of controlling human activity. If fencing is used, it is very important to ensure that it does not block wildlife movement to/from the habitat. Signage and a public education campaign may help people understand the unique characteristics of the habitat and the wildlife species that depend on it, and the value of leaving it undisturbed.

The PPS requires a balance such that there may be occasions when the proposed development is considered to be more in the public interest than the species of conservation concern. In these instances, thought should be given to providing habitat for the species elsewhere. This could involve creation of new habitat or transplanting into existing, unoccupied habitat. If this is being considered as a mitigation measure, it should be demonstrated that the new habitat is viable prior to the development taking place.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Some Special Concern and S1, S2 and S3 species have the potential to be affected by resource extraction activities, e.g., peat mining, sand and gravel pits, rock quarries, and mines.

Habitat for these species may be affected by direct habitat loss due to removal of resources or to placement of infrastructure within their habitat. This may include the installation of berms, dewatering ponds, maintenance and office buildings, roads and parking facilities, and storage areas for slag and tailings.

Indirect impacts may result from changes in drainage, changes in acidity and nutrient content of surface waters, changes in water table due to extraction or dewatering activities, and creation of edge effects.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the habitat to the finest ELC scale that protects the habitat form and function is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

The best mitigation is to avoid affecting the habitat of Special Concern and S1, S2 and S3 species. When complete avoidance is not possible, mitigation will necessarily be site specific depending upon the nature of the development and the species involved.

For species with aquatic phases, appropriate stormwater management will be required to ensure that water quality is not impaired and that there are no significant changes to the hydro-period. Runoff from parking lots and other facilities should be directed to stormwater management facilities if aquatic species of concern are present.

If there are species that are sensitive to flowing water, means of mitigating increased flow velocities should be investigated. These might include additional storage in stormwater management ponds or installation of baffles or other energy dissipation techniques. A water balance study will be required to determine impacts on hydro-period in wetlands and ponds that support species of conservation concern.

Hydrogeological studies may be required to determine if there will be changes in the water table that could potentially affect significant species. Depending upon the significance of the species that are potentially affected, mitigation may include installation of impermeable barriers around extraction areas or pumping to maintain existing groundwater conditions.

Tailings ponds and slag storage areas should be located in areas where they will not directly affect significant species and these areas must be completely contained so that contaminants and acid discharges do not leach from the area.

For terrestrial plant species, it may be possible to maintain microhabitat conditions by planting shrubs at the edge of retained vegetation communities. Areas that are intended for retention should not be physically disturbed as this may make conditions suitable for invasion by garlic mustard and other non-native plant species. As part of the stormwater management plan, the drainage area that retained communities are in should be defined. If the species of conservation concern is susceptible to changes in moisture regime, it should be demonstrated that the proposed development will not result in changes that will make the habitat unsuitable.

For terrestrial animals, it should be demonstrated that retained habitat will be capable of maintaining a viable population. This will require an assessment of the current viability of the population. Certain species may have limiting factors that are not related to habitat, so that simple retention of habitat may not suffice to ensure continued existence of the species on site. The Golden-winged Warbler is an example of such a species.

The PPS requires a balance such that there may be occasions when the proposed development is considered to be more in the public interest than the species of conservation concern. In these instances, thought should be given to providing habitat for the species elsewhere. This could involve creation of new habitat or transplanting into existing, unoccupied habitat. If this is being considered as a mitigation measure, it should be demonstrated that the new habitat is viable prior to the development taking place.

ENERGY DEVELOPMENT

Potential Development Effects: Biofuel Farms

The ploughing and subsequent conversion of fallow lands, meadows, and shrublands into farmland to grow crops for ethanol production (e.g., biomass feedstock such as corn and soy) may destroy critical habitat for significant species.

Mitigation Options: Biofuel Farms

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the habitat to the finest ELC scale that protects the habitat form and function is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

The best mitigation is to avoid affecting the habitat of Special Concern and S1, S2 and S3 species. When complete avoidance is not possible, mitigation will necessarily be site specific depending upon the nature of the development and the species involved.

If possible, habitat for the significant species should be maintained. As an alternative, areas that are unsuitable or marginal for biofuel production could be managed to provide habitat for the significant species, provided that there is sufficient area and the habitat is suitable for restoration for the species.

If the species is a plant and areas supporting it will be retained, these areas should not be sprayed with pesticides or treated with fertilizers. The drainage patterns of the habitat that supports the plant species should be maintained.

Potential Development Effects: Wind Power Facilities

The construction of turbine pads, access roads and other components of a wind power facility in habitat for Special Concern, S1, S2 and S3 species will result in its loss. Development on adjacent lands has the potential to reduce the ecological function of these habitats if it affects hydrology.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the edge of the SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. The area of the habitat to the finest ELC scale that protects the habitat form and function is the SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on the habitat. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing, excavation, dredging, draining and filling for development will destroy the affected habitat; the ecological function of the remaining habitat may be reduced or lost if the development alters hydrology. For some species, both plant and animal, human activities associated with the development may further reduce the habitat's ecological function (e.g., trampling, disturbance). The best mitigation option is to avoid developing in habitat for Special Concern, S1, S2 and S3 species.

When complete avoidance of the habitat is not possible, mitigation will necessarily be site specific depending upon the nature of the development and the species involved. As a general rule of thumb, minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; 2) placing it at an edge; and 3) placing it where it will affect the fewest Special Concern, S1, S2 and S3 species. Edge placement will maximize the amount of undisturbed habitat. Where the SWH is large, these measures may provide sufficient mitigation for habitat loss effects.

Other mitigations options may include leaving a buffer of natural vegetation between the development and the habitat to reduce disturbance effects. Schedule construction and regular maintenance activities to occur when wildlife species are not using the habitat. Prevent people, equipment and machinery from accessing retained habitat. Additionally, it may be possible in some cases to enhance existing habitat and/or create new habitat near or adjacent to retained existing habitat.

Potential Development Effects: Solar Power Facilities

Potential Development Effects will vary considerably depending on the species involved and the type of development that is proposed.

The installation of solar panels in habitat for plant species of special concern will destroy the affected habitat and the special concern plants. By design, solar panels capture sunlight that would normally reach the habitat. A dramatic reduction in sunlight will have significant impacts on the underlying plant community, likely leading to the loss of biomass and structure. Even where habitat is left intact (e.g., at the edge of the development), it may become degraded for a number of reasons. Removal of vegetation surrounding the ELC unit in which the habitat occurs may result in it becoming more exposed to wind and cooler temperatures; the site may also become invaded by species such as garlic mustard or buckthorn. Development or site alteration of adjacent land may also change the moisture regime and make the habitat less suitable or unsuitable for the species of conservation concern.

Development also results in increased human activity. Construction and regular maintenance activities may damage or destroy plants through trampling and the use of vehicles and equipment.

The site alterations required to develop in semi-aquatic and terrestrial habitats for species of conservation concern will damage or destroy the affected habitat. Impacts may also occur from the installation of solar panels and other project components on lands adjacent to the SWH.

For animal species that spend some of their life cycle in water (e.g., amphibians, dragonflies, damselflies), adjacent development may affect water quality and quantity. Some of the these species may be sensitive to excessive nutrients. If the development results in less groundwater flow to wetlands, ponds, or watercourses, certain species may not be able to complete their aquatic phase before the area dries up. Many water-dependent species are sensitive to water currents. Increased water flows as a result of development have the potential to reduce the suitability of the habitat for certain species.

For terrestrial animals, there are several potential impacts of development. Development and associated access roads may isolate species from key habitat areas that are used at different times during their life history. This is most critical for species that have both aquatic and terrestrial life phases, but also for those that move to different habitats for different seasons of the year. For area-sensitive species, the residual habitat may be too small to support a viable population. Disturbance by humans may also affect some species.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of the edge of the SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The area of the habitat to the finest ELC scale that protects the habitat form and function is the SWH. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing and other site alterations for development in habitats for Special Concern and S1, S2 and S3 species will damage or destroy the affected habitat. The best mitigation is to avoid developing in these habitats. When complete avoidance is not possible, mitigation will necessarily be site specific depending upon the nature of the development and the species involved. As a general rule of thumb, minimize the amount of habitat affected by making the development footprint where it affects the habitat as small as possible, and by siting the development at the edge of the habitat to minimize fragmentation.

For species with aquatic life-cycle phases, appropriate stormwater management will be required to ensure that water quality is not impaired and that there are no significant changes to the hydro-period. If there are species that are sensitive to flowing water, means of mitigating increased flow velocities should be investigated. These might include additional storage in stormwater management ponds or installation of baffles or other energy dissipation techniques. A water balance study will be required to determine impacts on hydro-period in wetlands and ponds that support species of conservation concern.

For terrestrial plant species, it may be possible to maintain microhabitat conditions by planting shrubs at the edge of retained vegetation communities. Areas that are intended for retention should not be physically disturbed as this may make conditions suitable for invasion by garlic mustard and other non-native plant species. As part of the stormwater management plan, the drainage area that retained communities are in should be defined. If the species of conservation concern is susceptible to changes in moisture regime, it should be demonstrated that the proposed development will not result in changes that will make the habitat unsuitable.

For terrestrial animals, it should be demonstrated that retained habitat will be capable of maintaining a viable population. This will require an assessment of the current viability of the population. Certain species may have limiting factors that are not related to habitat, so that simple retention of habitat may not suffice to ensure continued existence of the species on site. The Golden-winged Warbler is an example of such a species. To mitigate at least some disturbance effects, schedule high-disturbance activities (e.g., construction) to occur when animals are not using the habitat.

Fencing, education, and signage may be methods of controlling human activity. If fencing is used, it is very important to ensure that it does not block wildlife movement to/from the habitat. Signage and a public education campaign may help workers understand the unique characteristics of the habitat and the wildlife species that depend on it, and the value of leaving it undisturbed.

The PPS requires a balance such that there may be occasions when the proposed development is considered to be more in the public interest than the species of conservation concern. In these instances, thought should be given to providing habitat for the species elsewhere. This could involve creation of new habitat or transplanting into existing, unoccupied habitat. If this is being considered as a mitigation measure, it should be demonstrated that the new habitat is viable prior to the development taking place.

ROAD DEVELOPMENT

Potential Development Effects

Roads have the potential for direct loss of habitat for species of conservation concern. The footprint of the road along with associated shoulders, banks, and ditches will result in loss of habitat.

Indirect loss of habitat may occur through changes in hydrology, introduction of non-native plant species, introduction of sediments and other contaminants, and salt spray and runoff.

The road may act as a barrier to wildlife movement and may also result in increased incidence of road kill.

Mitigation Options

Development will not be permitted within the SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014). The area of the habitat to the finest ELC scale that protects the habitat form and function is the SWH.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

The best mitigation is to avoid affecting the habitat of Special Concern and S1, S2 and S3 species. When complete avoidance is not possible, mitigation will necessarily be site specific depending upon the nature of the development and the species involved.

When roads are built in close proximity to significant habitat, the key habitat components of the species should be identified and it should be determined how the road may indirectly affect these microhabitats. If sediments, excessive nutrients, and changes in hydrology are potential problems, surface water runoff from the road should be directed to stormwater management ponds prior to being discharged to the significant habitat.

Sufficient culverts should be installed under the road so that it does not form a barrier to groundwater or surface water flow. Natural flow to the significant habitat should be maintained.

It may be necessary to designate an area along the road as a "no-spray" area to ensure that significant plant species are not adversely affected. Planting the roadside with native flowers mixes (ensuring that the plants within the mix actually are native) may reduce the incidence of invasion of the significant habitat for the species by non-native species.

If the species or their habitats are susceptible to salt, an alternative de-icing compound may need to be used on the road surface.

If road kill is a potential problem, possible solutions include: installation of underpasses for wildlife, public education, signage, and traffic calming techniques such as speed humps.

MOVEMENT CORRIDORS

INDEX #38: BAT MIGRATORY STOPOVER AREAS

Ecoregions:	7E: 2
Species Group:	Hoary Bat, Eastern Red Bat, Silver-haired Bat
Significant Wildlife Habitat Category:	Seasonal Concentration Area
Functional Habitat:	Migratory Route/Stopover Areas
Habitat Features:	Location and characteristics are generally unknown The Little Brown Myotis (ENDANGERED) and Northern Long-Eared Myotis (ENDANGERED) are protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that may affect these species.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Information on all bat species is sketchy due to this group's nocturnal habits and the difficulty in distinguishing among their calls. New technology such as more advanced "bat detectors" and use of radar (EchoTrack 2005) is helping to add to knowledge, but information is still limited. Gerson (1984), OMNR (2006a), and van Zyll de Jong (1985) should be consulted for any project where bats are an issue.

Landscape features and associated habitat are important to bats, and forested ridge habitat may be especially important to bats during migration. Mortality at wind power facilities has been greater at installations situated on wooded ridge tops than those in grassland and agricultural areas (Kerns and Kerlinger 2004; Kerns et al. 2005; Nicholson et al. 2005; OMNR 2006a). Wetlands, ridge tops, and forest edge habitats are important areas for migrating bats (Verboom 1998). Lowest bat activity appears to occur in open flat areas that are at least 500 m from water bodies, riparian habitat, and forest edges (California Bat Working Group 2006; Lausen et al. 2006).

Three of the eight bat species that occur regularly in Ontario migrate long distances during late summer and early fall and over-winter south of the province. These include the Silver-haired Bat, Eastern Red Bat, and the Hoary Bat. The annual fall migration concentrates these species of bats at stopover areas. The location and characteristics of stopover habitats are generally unknown (Kunz and Fenton 2003).

The three migratory species may move several hundred kilometers between summer and winter habitat (Tuttle 1991). Essentially nothing is known about the routes that these species follow and information on where they winter is mostly anecdotal. Griffin (1970) summarized historical observations on bat captures, band recoveries, and sightings that assist in understanding the migration patterns of these species. The Hoary Bat may travel as far south as Mexico, while the Silver-haired Bat and the Red Bat may fly to the Ohio River valley for the winter (Barbour and Davis 1969; Cryan 2003). Possible stopover locations for these bats include the shorelines of large lakes and areas of high elevation (escarpment, cliff, large hills). For example, Long Point, Ontario appears to serve as an important migratory corridor (Hoary Bat, Silver-haired Bat), as well as a stopover and refueling site (Silver-haired Bat) (Dzal et al. 2009). There is also some evidence that Long Point serves as a migratory corridor for Little Brown Myotis enroute to winter hibernacula in the United States (Dzal et al. 2009).

The Silver-haired Bat may migrate in groups (Barbour and Davis 1969). Autumn migration for this species is generally from mid-August until early October (van Zyll de Jong 1985), but it has been observed in late October and November along the north shore of Lake Erie (OMNR 2006a). The autumn migration period for the Eastern Red Bat is predominantly late August until October while that of the Hoary Bat is from mid-August through October (van Zyll de Jong 1985). Migrating Hoary Bats may travel together in groups (Shump and Shump 1982). Data from wind power facilities indicate that over 50% of mortality occurs in August and that about 90% occurs from mid-July through September (Erickson et al. 2002). This corresponds approximately to what is known about the timing of autumn migration for Ontario's tree bats (Findlay and Jones 1964; Cryan 2003). Timing of spring migration is less certain, but is probably April to May in Ontario (van Zyll de Jong 1985). Unlike autumn, bat mortality at wind power facilities in spring and early summer is essentially nonexistent (Erikson et al. 2002).

Unlike many passerine bird species, it is uncommon for bats to make long, sustained flights during migration; evidence suggests that individual bats visit several stopover sites during long-distance movements (Kunz and Fenton 2003). One of the reasons for this may be that bats store less fat prior to migration than do passerines. For these reasons, stopover areas along the migration route, where individuals can rest and re-fuel before continuing, are very important to migrating bats. Critical resources at these migratory stopover areas need to be available in precise sequence both in time and space (Kunz and Fenton 2003). Poor quality stopover habitat (i.e., adequately spaced but providing inadequate foraging and/or roosting resources) may slow the progress of migration, expose migrants to deteriorating climatic conditions, and intensify competition enroute for resources. In hummingbirds, these effects of poor habitat quality have been shown to ultimately affect abundance (Russell et al. 1994, in Kunz and Fenton 2003).

Potential Development Effects

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Clearing and other site alterations in stopover habitat will result in direct habitat loss, and interrupt the continuity of resources along the migration corridor. Human activity at the project site can disturb bats using the habitat, thereby reducing the habitat's ecological function as a resting and re-fuelling site. Bats may also actively avoid structures, human activity, and/or noise (e.g., construction, roads) associated with the development, thereby indirectly losing habitat as a result of the development (OMNR 2011). Residential development may also lead to the persecution of bats by property owners over fears about rabies (Fredrickson and Thomas 1965).

Areas of high bat abundance and feeding activity during the migration season may indicate stopover habitat. The location and characteristics of stopover habitats are generally unknown, but areas most likely to attract migrating bats include forested ridge tops, wetlands, water with riparian cover and roosts (trees, woodlots, hedgerows, buildings) (Echo Track Inc. 2009). Land clearing for development in these areas may destroy critical migratory stopover habitat.

The types of commercial development that have a potential to affect the ecological function of bat migratory stopover habitat include high-rise apartment buildings, office towers, and communication towers. Impacts are mostly related to mortality due to nocturnal collisions with tall structures. Bats have been documented colliding with artificial structures such as communication towers, lighthouses and tall buildings (Avery and Clement 1972; Zinn and Baker 1979; Crawford and Baker 1981). It has been suggested that lights at these facilities may attract bats because of increased insect activity (Furlonger et al. 1987; Kunz 2004) but Horn and Arnett (2005), Johnson (2004), and Arnett et al. (2008) reported no difference in bat mortality at lit and unlit towers.

Forests on ridges are likely to attract migrating bats. Structures that are in or near forests have the greatest potential to result in bat mortality while open areas close to forests (100 m) have a moderate potential to result in mortality. Areas in grassland or farmland more than 100 m from forest have a relatively low probability of resulting in mortality (BCI Inc. 2005). The biggest threat to bats appears to be wind turbines. Mortality rates at other structures are relatively low (OMNR 2006a).

Mitigation Options

Development will not be permitted in bat migratory stopover SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance and/or bat persecution, in bat migratory stopover habitat will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat.

Although communications towers may be a concern, they are also subject to environmental assessments which often include both provincial and federal processes. These types of undertakings typically have gone through a rigorous review process before there are any triggers under the Planning Act.

Mitigation measures for tall commercial buildings include, whenever possible, locating the structure outside of forested ridges that have been identified as important bat migration concentration areas. Situating high-rises farther than 100 m from forested bat migration habitat should minimize the potential for bat mortality. Office buildings are likely to have greater potential to result in mortality as lights are more likely to be on during the night when bat migration is occurring, as opposed to apartment buildings.

If it is not possible to locate high-rises outside of areas that have moderate to high potential to result in bat mortality, then post-construction monitoring, similar to that required for wind power facilities (OMNR 2006a), should be undertaken to determine if bat mortality is occurring. As a general rule of thumb, schedule construction to occur when bats are not using the habitat.

In the case of apartment buildings, there are some design features that could reduce the potential for bat mortality. These include designing the building so that there are no hallways or stairwells with external windows that would have lights on at all times. Balconies should be designed to have external covers so that they break up light from apartment windows. There could also be a tenant awareness program to promote the use of shades and curtains to minimize external light during August and September, the period of most bat migration.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Clearing and other site alterations in stopover habitat will result in direct habitat loss, and interrupt the continuity of resources along the migration corridor. Human activity at the project site can disturb bats using the habitat, thereby reducing the habitat's ecological function as a resting and re-fuelling site. Bats may also actively avoid structures, human activity, and/or noise associated with the development, thereby indirectly losing habitat as a result of the development (OMNR 2011).

Areas of high bat abundance and feeding activity during the migration season may indicate stopover habitat. The location and characteristics of stopover habitats are generally unknown, but areas most likely to attract migrating bats include forested ridge tops, wetlands, water with riparian cover and roosts (trees, woodlots, hedgerows, buildings) (Echo Track Inc. 2009). Land clearing for development in these areas may destroy critical migratory stopover habitat.

Mitigation Options

Development will not be permitted in bat migratory stopover SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in bat migratory stopover habitat will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Clearing and other site alterations in stopover habitat will result in direct habitat loss, and interrupt the continuity of resources along the migration corridor. Human activity at the project site can disturb bats using the habitat, thereby reducing the habitat's ecological function as a resting and re-fuelling site. Bats may also actively avoid structures, human activity, and/or noise associated with the development, thereby indirectly losing habitat as a result of the development (OMNR 2011).

Areas of high bat abundance and feeding activity during the migration season may indicate stopover habitat. The location and characteristics of stopover habitats are generally unknown, but areas most likely to attract migrating bats include forested ridge tops, wetlands, water with riparian cover and roosts (trees, woodlots, hedgerows, buildings) (Echo Track Inc. 2009). Land clearing for development in these areas may destroy critical migratory stopover habitat.

Mitigation Options

Development will not be permitted in bat migratory stopover SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in bat migratory stopover habitat will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Migratory stopover habitat for bats can be directly affected by development through site alterations (e.g., vegetation clearing, filling) that result in habitat degradation or destruction. The ecological function of stopover habitat can also be affected where development causes reduced survival and/or productivity among bats using the habitat (e.g., through human disturbance and/or direct turbine-related bat mortality). Human disturbance that causes bats to avoid an area leads to indirect habitat loss.

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Areas most likely to attract migrating bats include forested ridge tops, wetlands, water with riparian cover and roosts (trees, woodlots, hedgerows, buildings) (Echo Track Inc. 2009). Clearing in these habitats for the construction of turbines, pads, access roads and other project components has the potential to result in the direct loss of critical stopover habitat, which would interrupt the continuity of resources along the migration corridor. Where clearing doesn't directly destroy stopover habitat, it may reduce feeding and roosting habitat used during stopovers.

Bats are very sensitive to disturbance. Human activity at the project site can disturb bats using the habitat, thereby reducing the habitat's ecological function as a resting and re-fuelling site. Bats may also actively avoid structures, human activity, and/or noise (e.g., construction, roads) associated with the development, thereby indirectly losing habitat as a result of the development (OMNR 2011).

Wind power developments can directly cause bat mortality through: 1) nocturnal collisions with wind turbine blades; and 2) barotrauma caused by a rapid reduction in air pressure near moving turbine blades (OMNR 2011). In an Alberta study, direct contact with turbine blades accounted for 50% of the bat fatalities recorded, and barotrauma was the cause of death in the other 50% (Baerwald et al. 2008). However, 90% of the fatalities showed evidence of internal haemorrhaging consistent with barotrauma, even where the apparent cause of death was physical trauma.

Wind power facilities have high potential for adversely affecting bats moving from swarming areas to roost sites and feeding areas (OMNR 2011), particularly during migration (Cryan and Barclay 2009; OMNR 2011). The long-distance migratory bats appear to be the most vulnerable to collisions with moving turbine blades (OMNR 2011). There is speculation that bats use the tallest trees in a landscape as gathering points, and may visually mistake turbines for the tallest trees, particularly before and during migration (Cryan 2008; Cryan and Brown 2007; Baerwald and Barclay 2009). This behaviour puts bats in close proximity to turbines, increasing their risk of mortality (bats do not appear to avoid rotating turbine blades (OMNR 2011)). Additionally, the creation of clearings in forested landscapes may contribute to bat mortality. Vegetation clearing for turbines, roads, transmission lines, and auxiliary buildings, especially where it is patchy in distribution, creates new edge habitat and new feeding opportunities that attract migrating bats (OMNR 2011). Attracting migrants to sites that are close to operating turbines may subsequently increase turbine-related bat mortality (OMNR 2011). In this way, these areas have the potential to become ecological traps for migrating bats.

The species most consistently affected by wind energy developments are those that rely heavily on trees for roosting throughout the year (Griffin 1970); these include Hoary Bat, Eastern Red Bat, and Silver-haired bat (Cryan and Barclay 2009). In North America, tree bats comprise about 75% of the fatalities documented at wind energy facilities, with hoary bats making up about half of all fatalities (Arnett et al. 2008).

Some researchers have postulated that lights at wind power facilities may attract bats because of increased insect activity (Furlonger et al. 1987; Kunz 2004), but Horn and Arnett (2005), Johnson (2004), and Arnett et al. (2008) reported no difference in bat mortality at lit versus unlit towers. Mortality is also greater with increasing turbine height (Barclay et al. 2007). Increased mortality may also occur with decreasing wind velocity (Horn et al. 2008), with most bats killed when winds are less than 6 km/hour (Arnett et al. 2008).

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of bat migratory stopover SWH should be avoided. The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the maternity colony or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2). The confirmation criteria and habitat areas for this SWH are still being determined.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in bat migratory stopover SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where bat activity is lowest. To the extent practicable, site turbines and other project components where they will not intercept bats flying between roosting and feeding areas (Echo Track Inc. 2009).

A pre-construction monitoring study for the proposed Harwich Wind Farm in Chatham-Kent, Ontario, recommends that turbines be placed to minimize and/or avoid the use of locations where feeding attractants such as water and riparian cover or roosts like trees, woodlots, some hedgerows and buildings are present (Echo Track Inc. 2009; OMNR 2011). For example, structures in open areas more than 100 m from forest have a relatively low probability of causing bat in mortality (BCI Inc. 2005).

Timing is another possible mitigation option. Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally (Mitchell-Jones 2004). Schedule short-term activities (e.g., construction, regular maintenance) near stopover habitat when bats are absent.

Most bat mortality at wind power facilities occurs during late summer through autumn, and tends to peak during autumn migration (Arnett et al. 2008; Cryan and Brown 2007). To mitigate mortality impacts, consider establishing protocols for de-activating (stopping) turbines at times of high bat activity (e.g., during migration) (Fenton et al. 2014). Studies have demonstrated that activity is highest on nights with wind speeds below 5.5 m/s (OMNR 2011). Bat mortality can also be mitigated by changing the cut-in speed, or altering the pitch angle of the blades to reduce rotor speed. These measures reduced bat fatalities in a southern Alberta study by 57.5% and 60.0% respectively (Baerwald et al. 2009). In Pennsylvania, decreased cut-in speeds reduced bat mortality by 53-87% with marginal annual power losses (Arnett et al. 2009).

Barclay et al. (2007) determined that bat fatalities increased exponentially with tower height, so minimizing tower height of turbines could significantly reduce bat fatalities.

Another possible mitigation option is the use of electromagnetic emissions to deter bats from entering the air space around operating turbines. In a British study, bat activity was significantly reduced near installations with electromagnetic (EM) fields of greater than 2 v/m (Nicholls and Racey 2007). Exposure to EM radiation is known to cause body heating in laboratory animals. If foraging bats are similarly affected, they may avoid areas with high EM fields where the thermal regime is inhospitable (Nicholls and Racey 2007). Bat responses to EM fields need to be studied further. Additionally, this mitigation option would only be appropriate if used in conjunction with a site selection mitigation that would ensure no interruption of foraging activities in and around the stopover habitat.

Work with the planning authority to determine what combination of Mitigation Options, if any, will work best for the situation at hand.

Potential Development Effects: Solar Power Facilities

Areas of high bat abundance and feeding activity during the migration season may indicate stopover habitat. The location and characteristics of stopover habitats are generally unknown, but areas most likely to attract migrating bats include forested ridge tops, wetlands, water with riparian cover and roosts (trees, woodlots, hedgerows, buildings) (Echo Track Inc. 2009).

Clearing and other site alterations in stopover habitat will destroy the affected habitat, and interrupt the continuity of resources along the migration corridor. Human activity at the project site can disturb bats using the habitat, thereby reducing the habitat's ecological function as a resting and re-fuelling site. Bats may also actively avoid structures, human activity, and/or noise (e.g., construction, roads) associated with the development, thereby indirectly losing habitat as a result of the development (OMNR 2011).

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of bat migratory stopover SWH should be avoided. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS), in accordance with any procedures established by the Ministry of Natural Resources, to determine what mitigation measures can be implemented to ensure there will be no negative effects on the maternity colony or its ecological function (Ontario Regulation 359/09:38.1.8 and 38.2). The confirmation criteria and habitat areas for this SWH are still being determined.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in bat migratory stopover SWH will destroy the affected habitat and interrupt the continuity of resources along the migration corridor. The best mitigation option is to avoid developing in the habitat. When complete avoidance is not possible, and the SWH is large, minimizing the amount of habitat affected may be a satisfactory mitigation option, e.g., make the development footprint where it affects the habitat as small as possible, and site it at the edge of the habitat where bat activity is lowest. Site the development where it will not interfere with bats flying between roosting and feeding areas (Echo Track Inc. 2009).

Timing is another possible mitigation option. Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally (Mitchell-Jones 2004). Schedule short-term activities (e.g., construction, regular maintenance) near stopover habitat when bats are absent.

ROAD DEVELOPMENT

Potential Development Effects

Clearing and other site alterations in stopover habitat will result in direct habitat loss, and interrupt the continuity of resources along the migration corridor. Human activity at the project site can disturb bats using the habitat, thereby reducing the habitat's ecological function as a resting and re-fuelling site. Bats may also actively avoid structures, human activity, and/or noise associated with the development, thereby indirectly losing habitat as a result of the development (OMNR 2011).

Areas of high bat abundance and feeding activity during the migration season may indicate stopover habitat. The location and characteristics of stopover habitats are generally unknown, but areas most likely to attract migrating bats include forested ridge tops, wetlands, water with riparian cover and roosts (trees, woodlots, hedgerows, buildings) (Echo Track Inc. 2009). Land clearing for development in these areas may destroy critical migratory stopover habitat.

Mitigation Options

Development will not be permitted in bat migratory stopover SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in bat migratory stopover habitat will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat.

INDEX #39: CERVID MOVEMENT CORRIDOR

Ecoregions:	All of Ontario
Species Group:	White-tailed Deer, Moose
Significant Wildlife Habitat Category:	Movement Corridor
Functional Habitat:	Migration Trail
Habitat Features:	Along riparian areas, woodlots, and/or areas of physical geography (e.g., ravines, ridges)

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Animals move for several reasons. Often a particular area does not satisfy all seasonal habitat requirements of a species. For example, many large mammals must range over large areas for all of their needs, or they must use different habitats in response to seasonal changes in climate (e.g., white-tailed deer, moose, caribou, and migratory birds). Often these animals follow traditional migration routes or corridors (OMNR 2000).

White-tailed Deer migrate seasonally between summer and winter range (most people refer to winter range areas as deer yards) (Voigt et al. 1997). As they move to and from winter range they usually travel through forest habitat taking advantage of the cover it provides. The same migration trails are used year after year (Aycrigg and Porter 1997; Van Deelen et al. 1998; Nelson and Mech 1999; Lesage et al. 2000). The cover provided by the corridor is significant to deer since, as they move to yards, they must travel through unfamiliar territory. Movement through unfamiliar habitat is risky owing to the fact that animals do not know where dangers tend to lie, and are not familiar with escape routes. Continuous forest cover with an undisturbed understory provides the security that deer need for safe travel while migrating. The presence of movement corridors becomes more significant closer to deer yards since progressively more deer utilize them. Corridors should radiate out in all directions from yards to ensure movement of deer from all areas of the surrounding landscape (Broadfoot et al. 1996). In many situations corridors provide protective cover for deer as they make forays to and from the yard to feed in nearby agricultural fields or on other food sources, such as acorns. Spring field-feeding opportunities on early grasses and forbs allow deer to begin to replenish energy supplies which have been depleted over the winter (Voigt et al. 1997).

For an area to function as a movement corridor for migrating deer it requires specific habitat features. Deer establish migration trails in forest habitat, often using terrain features such as ridges and valleys. The species composition of forest cover in movement corridors varies but conifer species appear to be important. The structure of the forest is more significant to deer than its composition, with forest understory characteristics contributing most to function. The forest understory of corridors should be well supplied with shrubs of various species.

It should be noted, however, that female deer in Illinois migrated between summer and winter habitats while males did not. The habitat in this study area was very open, and treed corridors were not available to migrating deer (Nixon et al. 2008). In Pennsylvania, the amount of forest cover was not related to the proportion of deer that migrated, but deer dispersed longer distances in forested habitat (Long et al. 2005). The proportion of deer that migrate annually is related to winter severity and accumulating snow depths as winter progresses (Fieberg et al. 2008).

Habitat requirements also change seasonally for moose. For example, moose are drawn to mineral lick sites to balance their consumption in the spring of food plants that are high in potassium. Later in the spring (typically mid- to late June), moose move into summer aquatic feeding areas. Movement corridors allow moose to travel freely to and from these critical habitats by providing cover, shelter from harsh weather conditions, and by minimising encounters with predators and people (OMNR 2000).

Potential Development Effects

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Developments that affect connectivity between forest patches or fragments cervid movement corridors (i.e., results in a higher edge to interior forest ratio) are of concern. The creation of multiple residential lots has the potential to totally disrupt movement corridor function if a significant proportion of the corridor is affected. The greatest impact would occur when the forest cover of the corridor is totally bisected.

Since deer tend to use the same movement corridors year after year, any structures which are placed in the corridor will be in the path of migrating deer. If the structures affect relatively little of the available forest cover of the corridor, deer will be able to pass by with less effect. As more of the width of the corridor is impacted, deer will have greater trouble avoiding buildings, fences, etc. As deer try to move through the subdivision, they may become entrapped by fences, hit by cars, chased by dogs, or create problems for residents such as feeding on ornamental trees and shrubs. If a corridor is completely severed, deer may be forced to seek an alternate route to the yard and if alternatives are not available, they will have to winter in unfamiliar habitat. This poses considerable risk to deer. Increases in deer mortality are likely and may contribute to an overall decline in deer numbers in an area measuring 10 times the size of the yard to which deer are migrating (Broadfoot et al. 1996). Suitable deer yards are in short supply and therefore deer often cannot simply move to another area.

Moose are intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Residential, cottage and commercial development leads to increased human activity, which has the potential to disturb moose using the corridor and may ultimately reduce moose use of the affected corridor.

Site alterations which reduce the width of the movement corridor will have negative impacts on migrating deer and moose. The greatest impacts are anticipated in situations where busy roads or residential areas are built so they must be traversed by deer or moose as they travel to and from the destination habitat. Loss of tree cover, and perhaps more significant, loss of hiding cover in the forest understory, can cause considerable difficulty for migrating deer and moose.

Single lots may also affect movement corridor function. Most severe impacts are expected when the lot is located in the narrowest section of an already narrow (i.e., < 100 m) movement corridor. As the width of the corridor declines, deer and moose will have greater trouble avoiding buildings, fences, etc.

Another impact of residential development on deer movement corridors is that increased human presence leads to increased artificial feeding of deer. MNRF offices in central Ontario have observed complete withdrawal of deer populations from an established deer yard because of artificial feeding. This results in more human-deer conflicts, deer vehicle accidents, more deer near houses, increases in predator conflicts with humans and deer populations residing in less than optimal winter habitat.

Mitigation Options

Development will not be permitted in cervid movement corridor SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing for development in cervid movement corridor habitat will destroy the affected habitat, and likely reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat. Movement corridors enable animals to move safely between specialised components of their habitat, e.g., winter deer yards, mineral licks, and summer aquatic feeding sites for moose. These habitats are critical to the survival of the wildlife species that use them. Corridors that connect these habitat components need to be protected from development; development should not sever these corridors (OMNR 2000).

For deer movement corridors, effects can be made less severe by directing activity away from narrow sections of the forested movement corridor and planning projects so permanent structures do not bisect the corridor. Minimize the amount of habitat affected by: 1) making the development footprint where it affects the habitat as small as possible; and 2) siting it as close to the edge of the corridor as possible. Development should always be designed to maintain the integrity of the corridors (width, habitat complexity, etc.).

Residential developments pose the greatest threat to migrating deer largely due to deer encounters with fences, cars, and dogs. Subdivisions which specify that property fences are not permitted will allow unobstructed deer movement through the area. This would greatly reduce the frequency of deer entrapment. A ban on dogs should also be considered. Speed limits on roads traversing movement corridors should be reduced, at least during spring (March, April) and autumn (November - January) migrations. Permanent traffic calming measures as installing speed humps or making roads with tight corners could also be considered. Deer crossing signs placed in areas where deer are most likely to cross roads may reduce the frequency of deer vehicle collisions. Although these mitigation techniques may reduce the impact of a development on migrating deer, certain of these measures are difficult to enforce. It is preferable to prevent impacts in the first place.

The sensitivity of moose to human disturbance may make it impossible to successfully mitigate the negative impacts of residential or commercial development in or adjacent to movement corridor habitat.

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

There is some potential for golf courses and ski resorts to affect cervid movement corridors.

Areas cleared for golf course fairways and ski runs have potential to reduce the function of a cervid movement corridor if they are constructed directly in the corridor area. This would be particularly true of openings that were aligned in the same direction as the corridor, as much more habitat would be removed than where an open swathe simply crossed the corridor.

Effects of human disturbance on migrating deer is not likely to be significant at golf courses, as the golf season typically does not correspond with periods when deer are moving to or from wintering areas. In contrast, ski resorts may be heavily used by humans when deer are moving.

Moose are intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Large-scale recreational development leads to increased human activity, which has the potential to disturb moose using the corridor and may ultimately reduce moose use of the affected corridor.

Mitigation Options

Development will not be permitted in cervid movement corridor SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing for development in cervid movement corridor habitat will destroy the affected habitat, and likely reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat. Movement corridors enable animals to move safely between specialised components of their habitat, e.g., winter deer yards, mineral licks, and summer aquatic feeding sites for moose. These habitats are critical to the survival of the wildlife species that use them. Corridors that connect these habitat components need to be protected from development; development should not sever these corridors (OMNR 2000).

For deer movement corridors, designing golf courses so that corridors are crossed at right angles to minimize the amount of affected corridor habitat may be a satisfactory mitigation measure. Additionally, widths of fairways should be minimized through corridors. Deer should continue to cross these areas, especially since human usage of the area will be minimal during the migration period. For ski resorts, it is important to site runs so that they do not intercept deer movement corridors. Even though those that cross at right angles may not affect much of the habitat, they result in the corridor becoming dysfunctional due to high disturbance. Many ski runs are active at night, with floodlights lighting up the runway, and skiers present. Additionally, snowmaking activities occur at night. Consequently, there may be almost constant activity along a ski run that may deter deer movement even if the changes to the habitat are relatively inconsequential.

The sensitivity of moose to human disturbance may make it impossible to successfully mitigate the negative impacts of large-scale recreational development in or adjacent to movement corridor habitat.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Large pits, quarries, and mines have the potential to sever cervid movement corridors. This may force deer to undertake detours around the development, which may be through marginal or unsuitable habitat. If the alternate route is unsuitable, deer may abandon traditional wintering habitat and be forced to use suboptimal habitat.

Moose are intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Increased human activity associated with aggregate and mine development in or adjacent to a moose movement corridor may disturb or block moose from using the corridor.

Mitigation Options

Development will not be permitted in cervid movement corridor SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Vegetation clearing for development in cervid movement corridor habitat will destroy the affected habitat, and likely reduce the ecological function of the remaining habitat. The best mitigation option is to avoid developing in the habitat. Movement corridors enable animals to move safely between specialised components of their habitat, e.g., winter deer yards, mineral licks, and summer aquatic feeding sites for moose. These habitats are critical to the survival of the wildlife species that use them. Corridors that connect these habitat components need to be protected from development; development should not sever these corridors (OMNR 2000).

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Any development that affects connectivity between forest patches or fragments cervid movement corridors (i.e., results in a higher edge to interior forest ratio) will reduce the ecological function of the corridor. Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Clearing for the construction of turbines, pads, transmission lines, access roads and other project components in cervid movement corridor habitat will destroy the affected habitat, and reduce or destroy the ecological function of the remaining habitat by blocking access to other critical habitats (e.g., winter deer yards, mineral licks, aquatic feeding areas for moose). The greatest impact will occur where the forest cover of the corridor is totally bisected.

Since deer tend to use the same migration trails year after year, any structures which are placed in the corridor will be in the path of migrating deer. If the structures affect relatively little of the available forest cover of the corridor, deer will be able to pass by with less effect. As more of the width of the corridor is impacted, deer will have greater trouble avoiding turbines, roads, etc. If a corridor is completely severed, deer may be forced to seek an alternate route to the yard and if alternatives are not available, they will have to winter in unfamiliar habitat. This poses considerable risk to deer. Increases in deer mortality are likely and may contribute to an overall decline in deer numbers in an area measuring 10 times the size of the yard to which deer are migrating (Broadfoot et al. 1996). Suitable deer yards are in short supply and therefore deer often cannot simply move to another area.

Moose are intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Human activities associated with construction and turbine maintenance will likely disturb moose using the migration trail if they are within visual range. Moose are also known to respond to noise in the environment, e.g., noise pollution and disturbance are listed as threats in Nova Scotia's recovery plan for mainland moose (NSDNR 2007). However, little seems to be known about moose responses to turbine noise in particular, or to the physical movement of turbines during operation. In a study of behavioural and physiological responses by moose to noise disturbance at a military site in Norway, Anderson et al. (1996) concluded that sources of disturbance identifiable by moose as human elicited flight responses at greater distances and elevated heart rates for longer periods than disturbances that were recognized as mechanical. This study was conducted in the fall; the authors caution that the same level of disturbance in the winter or during calving could have more detrimental effects.

Moose are known to avoid roads (AMEC Americas Limited 2005). Access roads across or near a movement corridor have the potential to reduce trail usage.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the edge of cervid migration trail SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in cervid movement corridor SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. Movement corridors enable animals to move safely between specialised components of their habitat, e.g., winter deer yards, mineral licks, and summer aquatic feeding sites for moose. These habitats are critical to the survival of the wildlife species that use them. Corridors that connect these habitat components need to be protected from development; development should not sever these corridors (OMNR 2000).

For development on lands adjacent to a cervid movement corridor, effects can be made less severe by minimizing the removal of forested habitat near the corridor. Leave a visual barrier of natural vegetation between the corridor and the project site. Schedule construction and, where possible, regular maintenance activities to occur when deer and moose are not using the corridor.

Potential Development Effects: Solar Power Facilities

Any development that affects connectivity between forest patches or fragments cervid movement corridors (i.e., results in a higher edge to interior forest ratio) will reduce the ecological function of the corridor. Clearing for the installation of solar panels, transmission lines, access roads and other project components in cervid movement corridor habitat will destroy the affected habitat, and reduce or destroy the ecological function of the remaining habitat by blocking access to other critical habitats (e.g., winter deer yards, mineral licks, aquatic feeding areas for moose). The greatest impact will occur where the forest cover of the corridor is totally bisected. Loss of tree cover, and perhaps more significant, loss of hiding cover in the forest understory, can cause considerable difficulty for migrating deer and moose.

Since deer tend to use the same migration trails year after year, any structures which are placed in the corridor will be in the path of migrating deer. If the structures affect relatively little of the available forest cover of the corridor, deer will be able to pass by with less effect. As more of the width of the corridor is impacted, deer will have greater trouble avoiding solar panels, roads, etc. If a corridor is completely severed, deer may be forced to seek an alternate route to the yard and if alternatives are not available, they will have to winter in unfamiliar habitat. This poses considerable risk to deer. Increases in deer mortality are likely and may contribute to an overall decline in deer numbers in an area measuring 10 times the size of the yard to which deer are migrating (Broadfoot et al. 1996). Suitable deer yards are in short supply and therefore deer often cannot simply move to another area.

Moose are intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Human activities associated with construction and solar panel maintenance will likely disturb moose using the migration trail if they are within visual range.

Moose are known to avoid roads (AMEC Americas Limited 2005). Access roads across or near a movement corridor have the potential to reduce trail usage.

The most severe impacts of forest clearing are expected when the development is located in the narrowest section of an already narrow (i.e., < 100 m) movement corridor. As the width of the corridor declines, deer and moose will have greater trouble avoiding structures, fences, roads, etc.

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of the edge of cervid migration trail SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in cervid movement corridor SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. Movement corridors enable animals to move safely between specialised components of their habitat, e.g., winter deer yards, mineral licks, and summer aquatic feeding sites for moose. These habitats are critical to the survival of the wildlife species that use them. Corridors that connect these habitat components need to be protected from development; development should not sever these corridors (OMNR 2000).

For development on lands adjacent to a cervid movement corridor, effects can be made less severe by minimizing the removal of forested habitat near the corridor. Leave a visual barrier of natural vegetation between the corridor and the project site. Schedule construction and, where possible, regular maintenance activities to occur when deer and moose are not using the corridor.

ROAD DEVELOPMENT

Potential Development Effects

Any development that affects connectivity between forest patches or fragments cervid movement corridors (i.e., results in a higher edge to interior forest ratio) will reduce the ecological function of the corridor. The greatest impacts are anticipated in situations where roads are built so they must be traversed by deer as they travel to and from wintering habitat. Loss of tree cover, and perhaps more significant, loss of hiding cover in the forest understory, can cause considerable difficulty for migrating deer.

Roads that intercept deer migration corridors are likely to result in collisions between deer and vehicles.

Moose are intolerant of human disturbance (Lykkja et al. 2009). Research suggests that human disturbance triggers anti-predator responses such as flight and elevated heart rate (Anderson et al. 1996; Neumann 2009). Increased disturbance associated with road development (vehicular and pedestrian traffic, noise) in or adjacent to a moose movement corridor may disturb or block moose from using the corridor.

Mitigation Options

Development will not be permitted in bat migratory stopover SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development, and development-related human disturbance, in cervid movement corridor SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. Movement corridors enable animals to move safely between specialised components of their habitat, e.g., winter deer yards, mineral licks, and summer aquatic feeding sites for moose. These habitats are critical to the survival of the wildlife species that use them. Corridors that connect these habitat components need to be protected from development; development should not sever these corridors (OMNR 2000).

Roads should always be designed to maintain the integrity of the corridors (width, habitat complexity, etc.). Ideally, roads would not cross movement corridors, but in some cases it will be impossible to completely avoid corridors. If roads must cross corridors, this should be done at perpendicular angles wherever possible. Road alignments should never run parallel to migration corridor.

Speed limits on roads traversing movement corridors should be reduced. Wildlife crossing signs placed in areas where deer or moose are most likely to cross roads may reduce the frequency of collisions with vehicles. In some areas, traffic calming measures may be introduced such as speed humps or twisting roads that require lower speeds.

Creation of underpasses for deer movement may be an option, but only under extreme circumstances. These circumstances would include a very high number of deer crossing the area on a regular basis accompanied by a road with high traffic volume. Generally, these types of roads are usually those associated with a municipal or provincial facility that is planned under the Environmental Assessment Act as opposed to the Planning Act.

In some areas, wildlife warning reflectors have been installed to reduce the incidence of deer-vehicle collisions. D'Angelo et al. (2006) found that these were ineffective.

INDEX #40: AMPHIBIAN MOVEMENT CORRIDOR

Ecoregions:	3E, 5E, 6E, 7E
Species Group:	Eastern (Red-spotted) Newt, Blue-spotted Salamander, Spotted Salamander, Northern Two-lined Salamander, Eastern Red-backed Salamander, Four-toed Salamander, Gray Treefrog, Spring Peeper, Chorus Frog, Wood Frog, American Toad, Northern Leopard Frog, Pickerel Frog, Green Frog, Mink Frog, Bull Frog
Significant Wildlife Habitat Category:	Movement Corridor
Functional Habitat:	(Wildlife) Movement Corridor The Jefferson Salamander (THREATENED) and the Small-mouthed Salamander (ENDANGERED) are protected under Ontario's Endangered Species Act, 2007. The Ministry of Natural Resources must be consulted regarding any development proposal that may affect these species.

DEVELOPMENT TYPES IN THIS INDEX

Residential and Commercial Development
Major Recreational Development
Aggregate and Mine Development
Energy Development
Road Development

HABITAT FUNCTION AND COMPOSITION

Woodland movement corridors are required to facilitate movement of amphibians to and from breeding ponds, to provide dispersal links to other nearby ponds, and to provide access to summer and winter habitat. Areas that are devoid of cover result in amphibians becoming dehydrated. Barren areas such as bare agricultural fields tend to be avoided by migrating frogs. Green Frogs and Northern Leopard Frogs may travel short distances across barren habitats to reach breeding ponds, but will take a longer route through less disturbed habitat if given a choice (Mazerolle and Desrocher 2005).

The persistence of many amphibian species at the landscape level often depends on dispersal of amphibians and recruitment from other wetlands (Semlitsch 2000). At an isolated wetland in South Carolina, Gibbons et al. (2006) found that amphibians arriving at the wetland did not immigrate from the direction of the only nearby wetland, but that they arrived from all directions. For most frog, toad, and treefrog species, terrestrial movements away or to a pond are typically random dispersals as opposed to following a distinct corridor. Certain salamander species, however, may follow traditional routes to reach breeding ponds. These routes usually follow topographical features such as ridges or valleys (Shoop 1965, 1968; Weller 1980). Vasconcelos and Calhoun (2004) found that both Spotted Salamanders and Wood Frogs exhibited selection in the direction they entered and left breeding ponds, and both species exhibited high site fidelity to the breeding pond over 2 years (98% of male Wood Frogs returned to breed, 88% of female Wood Frogs returned, and 100% of Spotted Salamanders returned).

Corridors must provide suitable habitat for these species to use them. The forest canopy of the corridor must not be opened up to the point that there is a loss of moisture in the understory. The supply of downed woody debris and other structure on the forest floor needs to be maintained to provide summer habitat for certain species.

For a woodland pond to continue functioning as a breeding pond for amphibians it must remain connected to surrounding woodland habitat to facilitate movement between the pond and surrounding terrestrial habitats. Both elements are required by most amphibians to complete their life cycles. Therefore, the pond and surrounding woodland habitat are integral components which must both be retained to ensure no loss of breeding pond function.

Movement to and from woodland ponds is easily disrupted if barriers are created. Barriers need not be extensive to stop or divert amphibian movement. Amphibians, particularly salamanders, tend to move in bursts when conditions allow. The pattern that emerges is one of localized activity followed by long-distance travel, usually at night when it is raining or at least when relative humidity is high (e.g., foggy nights). Gaps in forest canopy and understories denuded of vegetation, downed woody debris and other structures providing hiding cover, can severely curtail movement. Wooded movement corridors which provide unbroken links to isolated ponds are key to retaining their function as breeding or hibernating ponds.

To function as movement corridors for many amphibians, wooded strips must be wide enough to provide an interior area of moist woods. The forest canopy should be closed (> 60 % crown closure) and composed of deciduous trees (species composition may vary). There may be gaps in the canopy but they should not bisect the corridor (Calhoun and Klemens 2002). The forest understory should have an abundant supply of downed woody debris, shrubs, and other structures providing cover and moist microclimates (Calhoun and Klemens 2002). Some amphibians will also cross open areas such as old fields, pastures, hayfields, and golf course fairways.

Potential Development Effects

RESIDENTIAL AND COMMERCIAL DEVELOPMENT

Potential Development Effects

Development which results in the isolation of small woodland ponds from terrestrial woodland habitats will disrupt the function of the pond and the surrounding land for amphibians. The loss of the breeding pond will affect the population dynamics of essentially all amphibian populations in the vicinity of the development. Development in woodland strips which link ponds to surrounding woodlands may also affect the function of breeding ponds.

Tree cutting within woodland corridors acting as a link between the breeding pond and surrounding forest cover can disrupt pond functions if the forest canopy is opened up to the point that woods become dry or large gaps bisect the wooded strip. Lot-clearing activity may severely impact corridor function if it results in the loss of considerable structure (downed woody debris, etc.) from the understory.

Development that affects the moisture regime and results in drying of lands adjacent to the breeding pond may make the corridor habitat unsuitable. Drying that shortens the hydro period in the breeding pond may result in it becoming less suitable or unsuitable for breeding by certain species (Babbitt et al. 2003; Baldwin et al. 2006).

Mitigation Options

Development will not be permitted in amphibian movement corridor SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Developments should always be planned so that breeding ponds are protected and that the linkages between ponds and summer and winter range/habitat are maintained. Conservation efforts limited to the protection of individual ponds and vernal pools or even pools with associated upland habitat may be ineffective over the long term if connectivity among various habitats (including between vernal pools) is not maintained (e.g., due to the loss of individual wetlands or because of intervening roads or development) (Compton et al. 2007). The effects of development on breeding pond functions can be made less severe by ensuring that some forest habitat is left linking the pond to surrounding woodlands.

Steps need to be taken to ensure that forest cover remains intact around the breeding pond, allowing seasonal movement to and from the pond. Woodland corridors need to be relatively wide so that an interior of moist woods is provided. This is important since amphibians tend to move slowly through corridors, seeking cover and feeding habitat as they go. Therefore, corridors need to contain habitat features typical of woodland amphibian habitat in general. This includes maintaining downed woody debris that provides shelter for amphibians.

Calhoun and Klemens (2002) summarized a subdivision design that was successful in protecting a population of salamanders. Houses were clustered several hundred feet from the vernal pool, and no more than 50% of lots were cleared which resulted in much of the site being protected in its natural state. Other mitigation measures were applied at this subdivision. Stormwater moves through a grassy swale and into an open, biofiltration wetland which minimizes mortality of salamanders and other wildlife caught in catch basins. Low gradient curbing was used to allow salamander movement. Additional restrictions at this subdivision regulated the design of individual driveways, the use of pesticides, herbicides, and salts, and exterior lighting.

Calhoun and Klemens (2002) provided general guidelines for protecting amphibian habitat around vernal pools. They identified two zones around the vernal pool: the vernal pool envelope and the critical terrestrial habitat. The vernal pool envelope was defined as the area within 30 m of the pool's edge. Within this zone, they recommended that an undeveloped forested habitat is maintained around the pool, including both canopy and understory; that barriers to amphibian dispersal be avoided; that pool hydrology and water quality be maintained; and that this area be pesticide free. The critical terrestrial habitat was defined as that area within 30 to 228 m (750 ft) of the vernal pool (assuming that all of this area is forested). Calhoun and Klemens recommended maintaining or restoring 75% of this zone in contiguous forest with undisturbed canopy and understory; maintaining or restoring forested corridors that connect wetlands or vernal pools; maintaining at least a partially closed-canopy stand that will provide shade, litter, and woody debris; minimizing disturbance to the woodland floor; and maintaining native understory vegetation where possible.

Calhoun and Klemens (2002) also recommended that these guidelines be used as a planning tool, with the municipality completing inventories of vernal pools and assigning a priority for conservation targets. They recommended that conservation efforts be focused on:

1. ecologically significant pools along size and hydro period (length of time the pool holds water) gradients in order to protect a wide diversity of pool-breeding invertebrates and amphibians;

2. pools with intact critical terrestrial habitat;

3. pools with long-term conservation opportunities (e.g., pools on public land, not-for-profit lands, or in large tracts of relatively undisturbed private ownership); and

4. maintaining or restoring the adjacent terrestrial habitat for pools in agricultural or suburban/landscaped settings where the amount of forest cover is limited. (Although forest landscapes are preferred habitat, unfragmented agricultural lands support dispersal of many amphibians and have the potential to become even more valuable following old field succession or reforestation.)

MAJOR RECREATIONAL DEVELOPMENT

Potential Development Effects

Golf courses are the type of major recreational development most likely to affect amphibian movement corridors.

Development which results in the isolation of small woodland ponds from terrestrial woodland habitats will disrupt the function of the pond and the surrounding land for amphibians. The loss of the breeding pond will affect the population dynamics of essentially all amphibian populations in the vicinity of the development. Development in woodland strips which link ponds to surrounding woodlands may also affect the function of breeding ponds.

Tree cutting within woodland corridors acting as a link between the breeding pond and surrounding forest cover can disrupt pond functions if the forest canopy is opened up to the point that woods become dry or large gaps bisect the wooded strip. Lot-clearing activity may severely impact corridor function if it results in the loss of considerable structure (downed woody debris, etc.) from the understory.

Development that affects the moisture regime and results in drying of lands adjacent to the breeding pond may make the corridor habitat unsuitable. Drying that shortens the hydro period in the breeding pond may result in it becoming less suitable or unsuitable for breeding by certain species (Babbitt et al. 2003; Baldwin et al. 2006).

McDonough and Paton (2007) studied movements of radio-tracked Spotted Salamanders on a Connecticut golf course. They found that salamanders crossed fairways and that they were not a barrier to movement. Females moved farther than males. The authors suggested that protecting 164 m of upland habitat around the breeding pond would include 82% of adult males and 50% of females. To protect 95% of females, the core area around the pond would have to extend to 370 m.

Mitigation Options

Development will not be permitted in amphibian movement corridor SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Golf courses should always be planned so that breeding ponds are protected and that the linkages between ponds and summer and winter range/habitat are maintained. If fairways must intercept amphibian movement corridors, the fairways should be as narrow as possible and aligned so that they are perpendicular to the movement corridor as opposed to along it or immediately adjacent and parallel to it.

Conservation efforts limited to the protection of individual ponds and vernal pools or even pools with associated upland habitat may be ineffective over the long term if connectivity among various habitats (including between vernal pools) is not maintained (e.g., due to the loss of individual wetlands or because of intervening roads or development) (Compton et al. 2007). The effects of development on breeding pond functions can be made less severe by ensuring that some forest habitat is left linking the pond to surrounding woodlands.

Steps need to be taken to ensure that forest cover remains intact around the breeding pond, allowing seasonal movement to and from the pond. Woodland corridors need to be relatively wide so that an interior of moist woods is provided. This is important since amphibians tend to move slowly through corridors, seeking cover and feeding habitat as they go. Therefore, corridors need to contain habitat features typical of woodland amphibian habitat in general. This includes maintaining downed woody debris that provides shelter for amphibians.

Calhoun and Klemens (2002) also provided general guidelines for protecting amphibian habitat around vernal pools. They identified two zones around the vernal pool: the vernal pool envelope and the critical terrestrial habitat. The vernal pool envelope was defined as the area within 30 m of the pool's edge. Within this zone, they recommended that an undeveloped forested habitat is maintained around the pool, including both canopy and understory; that barriers to amphibian dispersal be avoided; that pool hydrology and water quality be maintained; and that this area be pesticide free. The critical terrestrial habitat was defined as that area within 30 to 228 m (750 ft) of the vernal pool (assuming that all of this area is forested). Calhoun and Klemens recommended maintaining or restoring 75% of this zone in contiguous forest with undisturbed canopy and understory; maintaining or restoring forested corridors that connect wetlands or vernal pools; maintaining at least a partially closed-canopy stand that will provide shade, litter, and woody debris; minimizing disturbance to the woodland floor; and maintaining native understory vegetation where possible.

AGGREGATE AND MINE DEVELOPMENT

Potential Development Effects

Pits, quarries, and mines could potentially be established within amphibian movement corridors. These areas may pose considerable barriers to amphibian movements due to the steep slopes of the excavations, the openness of these areas, and their dryness.

Excavation, dewatering activities, and lowering of the local water table may dry out adjacent areas that are amphibian movement corridors, thus affecting their attractiveness to amphibians.

Mitigation Options

Development will not be permitted in amphibian movement corridor SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Where possible, pits, quarries, and mines should never be situated where they will interrupt significant migrations of amphibians between breeding areas and summer habitat.

In the case of sand and gravel pits where all excavation is above the water table, rehabilitation of the pit can involve creation of habitat that amphibians may use as a migration corridor. This may include treed areas with logs and other downed woody debris.

If an existing corridor may be affected indirectly by a pit, quarry, or mine due to changes in hydrology or lowering of the water table, it may be possible to mitigate this through appropriate water management techniques. If extraction or dewatering result in a lower water table and subsequent drying of a corridor where it is not suitable for amphibian migration, it may be possible to re-establish the moisture regime through pumping or creating impermeable membranes around the pit or quarry so that external water tables are not affected.

ENERGY DEVELOPMENT

Potential Development Effects: Wind Power Facilities

Turbines require open space around them, free of trees and other turbines; on average, 12-28 ha of open space is required for every megawatt of generating capacity (National Wind Watch n.d.; Rosenbloom 2006). Land clearing in amphibian movement corridor habitat represents a direct loss of habitat.

Development that opens woodland habitat also tends to dry the habitat. Dry conditions greatly reduce the quality of woodland habitat for most amphibians. Where clearings bisect a movement corridor, drier conditions in the opening will block many amphibians from crossing the opening, which effectively destroys the ecological function of the corridor for those species.

Development that damages movement corridors, resulting in the isolation of small woodland ponds from terrestrial woodland habitats, will disrupt the function of the pond and the surrounding land for amphibians. The loss of the breeding pond will affect the population dynamics of essentially all amphibian populations in the vicinity of the development.

Mitigation Options: Wind Power Facilities

The siting of wind turbines within 120 m of the edge of amphibian movement corridor SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). The 120 m setback is from the tip of the turbine blade when it is rotated toward the habitat, as opposed to from the base of the turbine. Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is generally the most important component of a successful mitigation strategy for wind power developments (Everaert and Kuijken 2007; OMNR 2011). Turbines should be located as far from SWH as possible. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Clearing for development in amphibian movement corridor SWH will likely result in reduced ecological function or loss of the habitat. The best mitigation option is to avoid developing in the habitat. Movement corridors enable animals to move safely between specialised components of their habitat. Corridors that connect these habitat components need to be protected from development; development should not sever these corridors (OMNR 2000).

Developments should always be planned so that breeding ponds are protected and that the linkages between ponds and summer and winter range/habitat are maintained. Conservation efforts limited to the protection of individual ponds and vernal pools or even pools with associated upland habitat may be ineffective over the long term if connectivity among various habitats (including between vernal pools) is not maintained (e.g., due to the loss of individual wetlands or because of intervening roads or development) (Compton et al. 2007). The effects of development on breeding pond functions can be made less severe by ensuring that some forest habitat is left linking the pond to surrounding woodlands.

Steps need to be taken to ensure that forest cover remains intact around the breeding pond, allowing seasonal movement to and from the pond. Woodland corridors need to be relatively wide so that an interior of moist woods is provided. This is important since amphibians tend to move slowly through corridors, seeking cover and feeding habitat as they go. Therefore, corridors need to contain habitat features typical of woodland amphibian habitat in general. This includes maintaining downed woody debris that provides shelter for amphibians.

Potential Development Effects: Solar Power Facilities

Vegetation clearing for the installation of solar panels, access roads and other project components in amphibian movement corridor habitat will destroy the affected habitat, and damage or destroy the ecological function of associated breeding ponds.

Development that opens woodland habitat also tends to dry the habitat. Dry conditions greatly reduce the quality of woodland habitat for most amphibians. Where clearings bisect a movement corridor, drier conditions in the opening will block many amphibians from crossing the opening, which effectively destroys the ecological function of the corridor for those species.

Development that damages movement corridors, resulting in the isolation of small woodland ponds from terrestrial woodland habitats, will disrupt the function of the pond and the surrounding land for amphibians. The loss of the breeding pond will affect the population dynamics of essentially all amphibian populations in the vicinity of the development.

Development that affects the moisture regime and results in drying of lands adjacent to the breeding pond may make the corridor habitat unsuitable. Drying that shortens the hydro period in the breeding pond may result in it becoming less suitable or unsuitable for breeding by certain species (Babbitt et al. 2003; Baldwin et al. 2006).

Mitigation Options: Solar Power Facilities

The siting of solar panel arrays within 120 m of the edge of amphibian movement corridor SWH should be avoided (Ontario Regulation 359/09:38.1.8 and 38.2). Applicants wishing to develop within the SWH or the 120 m setback must conduct an Environmental Impact Study (EIS) to determine what mitigation measures can be implemented to ensure there will be no negative effects on the habitat or its ecological function.

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

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ROAD DEVELOPMENT

Potential Development Effects

Amphibians are not all affected by road development in the same way. The abundance of the Mink Frog and the Wood Frog, for example, are negatively related to road density, while the abundance of the Pickerel Frog is not affected significantly by road density but shows significant positive association with adjacent forest cover (Findlay et al. 2001). Eigenbrod et al. (2008) studied the relationships among amphibian abundance, forest cover, and road traffic near Ottawa. They found that presence of amphibians was negatively correlated with presence of roads and that this negative relationship was stronger than the positive association that amphibians demonstrated with forest cover. Results were species specific. American Toad, Northern Leopard Frog, and Gray Treefrog showed stronger associations with traffic than forest cover; Wood Frog and Spring Peeper showed stronger associations with forest cover than traffic; while Green Frog showed similar associations between traffic and forest cover. Species-specific consideration should be taken into account when both identifying impacts and contemplating appropriate mitigative actions.

Roads which create gaps in forest cover may act as barriers to movement to and from ponds, while fragmenting habitat. Busy roads built in forest cover acting as a link to amphibian breeding (and hibernating) ponds will result in increased mortality. Large numbers of amphibians are killed on highways and other roads when they are migrating among habitats used in different phases of their life cycle. High mortality in the vicinity of ponds and wetlands may jeopardize long-term persistence of some amphibian populations. Amphibians are especially vulnerable to being killed on roads in the spring when they are migrating to breeding ponds, but warm roads are attractive for resting.

Mitigation Options

Development will not be permitted in amphibian movement corridor SWH unless it can be demonstrated that there will be no negative impacts on the feature or its ecological function (OMNRF 2014).

Site selection is typically an important component of a successful mitigation strategy. Best practices for site selection should also include consideration of cumulative impacts on bats and their habitats. For example, planners should account for known impacts in neighbouring developments and the cumulative amount of disturbed/converted habitat relative to the amount of undisturbed habitat (OMNR 2011).

Attention should be paid to preventing the migration of silt/sediments during road construction, as sedimentation can negatively affect both pond habitat and vegetated movement corridors. Road systems need to be designed so that they do not run parallel to breeding ponds or cut off migration routes between critical habitats.

Culverts or underpasses may be required to permit passage of amphibians. If culverts or underpasses are considered necessary and feasible, it is important that an appropriate design is selected to ensure that maximum numbers of amphibians will use them. McCormack Rankin Corporation and Ecoplans Limited (2002) completed a detailed literature review on design guidelines for tunnels or culverts intended to provide passage for amphibians under roads. They concluded that box, circular, and elliptical shaped culverts were equally effective in allowing passage of amphibians, and that there appeared to be no difference whether the culverts were concrete or steel. In order for a culvert to be used, it is important that amphibians can see light through it. Therefore, the diameter of the culvert must increase with increasing length. If open grates are provided along the culvert to allow extra light penetration, it may be possible to reduce the diameter of the culvert. Amphibians are known to use culverts that are at least 40 m in length, and culverts of this length should be a minimum of 1 m in diameter. Moisture in the culvert is an important criterion. There should be enough moisture in the culvert during wet weather to result in a flow of water through the culvert, but without excessive ponding, flooding, and high water velocities. There should be no drainage patterns perpendicular to either mouth of the culvert that might direct amphibians away from the culvert. It is important that there is substrate in the culvert, and 15 cm of native soil should be placed in it to facilitate amphibian passage. The best designs incorporate a perpendicular wall at each end of the culvert that runs parallel to the road, or out from it on an angle. This should be designed such that it prevents amphibians from accessing the road surface and directs them into the culvert.

Holtz et al. (2008) examined road crossing structures for amphibians in New York and found that different species preferred different designs. They concluded, however, that tunnels larger than 0.5 m in diameter lined with soil or gravel and accompanied by 0.6-0.9 high fencing would best facilitate road crossing for most amphibian species. The Green Frog preferred tunnels with the greatest light permeability.

Wildlife Crossings Info (2007) provides information on wildlife crossings, including both underpasses and overpasses.

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APPENDIX

Appendix of Species Habitat Requirements

This appendix contains information about habitat requirements for selected species from the Habitat Indices.

From Index #1 and #12: Bat Hibernacula and Maternity Colonies

The following table summarizes the general habitat requirements of species in this guild.

Species	Habitat Characteristics
Big Brown Bat	Regularly hibernates in buildings as well as caves and abandoned mines. Tolerates a greater temperature range and lower relative humidity during winter than all other Ontario bats (Barbour and Davis 1969; Fenton 1972). Prefers roosting in buildings (Gerson 1984). Nursery colonies typically located in attics and barns, behind shutters and sliding doors, and between building wings (Barbour and Davis, cited in Gerson 1984, Mulheisen and Berry 2000); have been known to use bat boxes when available. Prior to settlement, nursery colonies were in tree hollows, natural caves, under bark, or openings in rock ledges/crevices and are still occasionally found in these locations as well as under bridges (Baker 1983 in Mulheisen and Berry 2000, Barbour and Davis, cited in Gerson 1984, Fenton et al. 2005a). Prefer roosting in cooler places than the Little Brown Myotis and will move to cooler areas when temperatures rise above thirty-three to thirty-five degrees (33o-35oC) (Gerson 1984). Maternity colonies may contain from 20 to 300 individuals. Most adult females return to the same maternity roost site in successive years (Hammerson 1994). Found in various wooded and semi-open habitats, including cities; is much more abundant in regions dominated by deciduous forest than in coniferous forest areas (Hammerson 1994, Kalcounis et al. 1999).
Tri-colored Bat	Selects warm, draftless, humid spots within caves and mines for hibernating. May be found in small caves that are unsuitable for other species, but it also occurs in larger caves (Hitchcock 1949; Barbour and Davis 1969). Rarely use buildings, however small numbers have been found on occasion in buildings in the U.S. (Gerson 1984). Typically roost in rock crevices, caves, tree hollows, and are most frequently found roosting in tree foliage in the summer (Veilleux et al. 2003; Briggler and Prather 2003; Hamlin and Myers 2004). Can be found in open woods near the edges of water, as well as over water, and are seldom found in open fields or deep forests (Hamlin and Myers 2004).
Silver-haired Bat	Prefer temperate, northern hardwoods with ponds or streams nearby (Naumann 1999). Generally found in forests and spends days roosting under loose bark (Fenton et al. 2005a) and tree hollows (Parsons et al. 1986), and appears to be fond of willow, maple and ash trees (Naumann 1999). Hollow snags and bird nests are also used as day roosts (Naumann 1999). No records of nursery colonies in buildings exist, nor are there records from caves or mines in Ontario (Fenton et al. 2005a). Maternity colonies are small, approximately 10 adults (Parsons et al. 1986). Migrates south in the winter.

From Index #3: Mast Producing Areas

The following table summarizes the general habitat requirements of species in this guild.

Species	Habitat Characteristics
Black Bear	Outside of the denning season (mid-October to mid-April), black bears seek areas providing seasonally-abundant foods. They often make extensive movements (40 to 80 km) to get to these unique feeding areas (Kolenosky and Strathearn 1987; OMNR 2007a). During spring, bears seek forest openings and field edges where they can eat succulent new shoots of grasses and sedges and poplar catkins (Kolenosky and Strathearn 1987). From mid-May until early June, bears feed heavily on trembling aspen leaves. Although highly digestible, these early spring foods may serve as interim fillers until more nutritious foods become available. It is not until bears switch to their summer diet that they begin to gain weight (Kolenosky and Strathearn 1987). During summer, bears seek areas where fruit is abundant. Bears usually seek areas where blueberries are common, but also visit areas offering other berry crops (i.e. strawberries, sarsaparilla, raspberries, pin cherries, service berries, apples, etc) (Kolenosky and Strathearn 1987). During autumn, bears seek forest stands providing hard mast (oak and beech nuts). Access to abundant berry and nut supplies is particularly important as bears must eat enough high quality food to allow them to build up the large fat reserves that they need to survive the winter (Kolenosky and Strathearn 1987). During spring and summer, forest openings provide most of the foods that bears require. As snow melts in the spring and bears first start foraging, they visit grassy areas where they are able to find growing stems of grasses and sedges (Kolenosky and Strathearn 1987). During summer, bears will visit open areas providing raspberries and blueberries (Kolenosky and Strathearn 1987). In the fall, most bears seek forest ridges offering a supply of acorns. Bears will also seek stands of American beech, climbing the trees to eat beechnuts (Kolenosky and Strathearn 1987). Evidence of past use of maple/beech stands is displayed as easily-seen claw marks in trees and branches broken inward toward main branches forming a "bear nest" in the crown of large beech trees.
Ruffed Grouse	Nests in early successional forests (Gullion 1977; James and Peck 1995; Johnsgard 1983); strongly associated with poplar and aspen stands but also occurs in other forest types (Atwater and Schnell 1989; Cade and Sousa 1985; Gullion 1977; Johnsgard 1983); nests at the edge of forests or near small openings or disturbances in forests such as bush roads (Bump et al. 1947; Cade and Sousa 1985; Johnsgard 1983); relatively sedentary (Baillie 1956; Theberge and Gauthier 1982); hunted populations need forests of about 25 ha in order to maintain populations, about 20 ha has been considered the minimum habitat area for isolated forests surrounded by unsuitable grouse habitat (Cade and Sousa 1985), but it is uncertain if hunting was taken into consideration in this recommendation.

From Index #4: Colonially-Nesting Bird Breeding Habitat (Bank/Cliff)

The following table summarizes the general habitat requirements of species in this guild.

Species	Habitat Characteristics
N. Rough-winged Swallow	Prefers open areas, including open woodlands. Fairly common throughout breeding range, but local distribution depends on suitable nest sites. Predominantly near rocky gorges, shale banks, stony road cuts, railroad embankments, gravel pits, eroded margins of streams, and other such exposed banks of clay, sand, or gravel. May accept any cavity or crevice in vertical surface, including gutters, culverts, drainpipes, and crevices or holes in walls, wharves, bridges, etc. Often nests near open water, but water likely coincidental with occurrence of suitable nest site (De Jong 1996).
Cliff Swallows	Cliff Swallows originally inhabited open canyons, escarpments, and river valleys that offered a vertical cliff face with a horizontal overhang for nest attachment. Many still nest in these habitats, but others have adapted to nesting on man-made structures such as buildings and under bridges. Cliff Swallows prefer open areas near water, where insects and mud are plentiful (Terres 1980). Agricultural and riparian areas are usually nearby. Nests are typically bottle- or flask-shaped mud structures with a narrow entrance on the side, but they can also be simple mud cups similar to the nests of Barn Swallows. Nests are placed at junctures of vertical wall and horizontal overhang, and may be anywhere from 1.5 m to ≥10 m above ground or water surface. On cliff sites, the distribution of overhangs usually dictates where nests can be placed and accounts for irregular distribution of nests within colony. Successive arrivals often build nests directly below first tier of nests, offsetting nests slightly in honeycombed pattern. Cliff sites vary substantially in height, but are always open and free of vegetation, allowing birds an unobstructed flight path to and from nests. Colonies can number from just a few nests to 1,000 or more, and typically occur on sites protected from ground predators. Cliff Swallows apparently have specific nesting requirements that are as yet unknown, as their distribution is patchy, and there are many areas that appear to be suitable habitat that host no Cliff Swallows (Terres 1980, Brown and Brown 1995). The absence of colonies from some cliffs may reflect substrate composition; birds apparently avoid nesting on unstable sandstone which crumbles frequently (Brown and Brown 1995). Cliffs composed of limestone, dolostone and/or sandstone are most prevalent along the Niagara Escarpment, from Manitoulin Island to near Niagara-on-the-Lake. Granite cliffs are more widespread in the province, but metamorphic/granitic cliffs are only found on the Frontenac axis in Site Region 6E (OMNR 2000).

From Index #5: Colonially-Nesting Bird Breeding Habitat (Tree/Shrub)

The following table summarizes the general characteristics of the nesting habitat of species in this guild when they are nesting within forested habitat.

Species	Habitat Characteristics
Great Blue Heron	Nests in dead trees in large marshes and lakes (Peck and James 1983); nests near the top of trees and is dominant over other smaller species that may nest in the same colony (Buerkle and Mansell 1963); most nests are 11 to 15 m from ground (Peck and James 1983); readily adapts to using artificial nesting structures (Sandilands 1980); may nest with Double-crested Cormorant, Great Egret, Cattle Egret, Green Heron, Black-crowned Night-Heron, and Osprey (Peck and James 1983); as many as 18 nests have been found in a single tree (Peck and James 1983); in the south, it tends to nest in large deciduous swamps (Dunn et al. 1985); these colonies may be used for several years, although the birds' excrement may eventually kill the trees (Dunn et al. 1985; Graham et al. 1996); nesting colonies in the south tend to be much larger than in the north (Dunn et al. 1985; Graham et al. 1996); on the Shield, it frequently nests in much smaller colonies in standing timber in beaver ponds; these heronries are often used for only a few years (Dunn et al. 1981; Graham et al. 1996); forages singly or with conspecifics, most often by slowly wading or standing in wait of prey in shallow water; eats mostly fish, but also amphibians, invertebrates, reptiles, mammals and birds (Butler 1992).
Great Egret	Nests in flooded timber and shrubs adjacent to wetlands (Peck and James 1983); prefers to nest on forested islands (Peck and James 1983); may also nest in bulrushes and on the ground (Bent 1926; Burger 1978), although this has not yet been documented in Ontario; nested in cattails and buttonbush on Walpole Island (Peck in Cadman et al. 1987); most nests in trees are 4.5 to 9 m from the ground (Peck and James 1983); may nest with Great Blue Herons, Cattle Egret, Green Heron, and Black-crowned Night-Heron (Peck and James 1983) and Double-crested Cormorant; feeds in a wide variety of wetland habitats, including marshes, swamps, streams, rivers, ponds, lakes, impoundments, lagoons, canals, ditches and fish-rearing ponds; eats mainly fish, but also invertebrates (particularly crustaceans), amphibians, reptiles, birds, and small mammals (Mccrimmon et al. 2001).
Green Heron	Occasionally nests in flooded timber but more often in shrubs adjacent to or in wetlands (Peck and James 1983); in wetlands, most nests are over water or very close to it, but may nest in upland habitats considerable distances from wetlands (Peck and James 1983; Sandilands 2005); during the second atlas, a colony of 14 nests was found on the ground among raspberry bushes (Sandilands 2007b); nest heights above water are usually 3 to 6 m, but may range from 0.2 to 15 m (Peck and James 1983); if larger herons are present in the same colony, it is forced to nest lower (Buerkle and Mansell 1963); feeds in swamps, riparian zones along creeks and streams, also marshes, ditches, canals, ponds, lake edges, open floodplains, pastures, mudflats and harbors; prefers thick vegetation throughout range, but will feed in open when food is available; typically eats fish, but prey selection is broad and includes all sorts of invertebrates (Davis and Kushlan 1994).

Black-crowned Night-Heron	Nests near water including flooded trees and shrub thickets over and adjacent to water (Peck and James 1983); usually nests in deciduous species, occasionally conifers (Peck and James 1983); rarely nests in emergent vegetation in marshes (Peck and James 1983); most nests are 2 to 4 m above water, but they may be as low as 0.3 m and as high as 12 m (Peck and James 1983); prefers to nest in isolated areas that are protected from human disturbance and mammalian predators, such as islands and tips of peninsulas (Peck and James 1983); the majority of Ontario's colonies contain fewer than 50 nests (Weseloh 2007); prefers shallow, weedy pond margins, creeks, and marshes for feeding; takes a wide variety of foods, including leeches, earthworms, aquatic and terrestrial insects, crayfish, mussels, fish, amphibians, lizards, snakes, rodents, birds, eggs, carrion, plant materials, and garbage/refuse at landfills (Davis 1993).

From Index #6: Colonially-Nesting Bird Breeding Habitat (Ground)

The following table summarizes the general habitat requirements of species in this guild.

Species	Habitat Characteristics
Ring-billed Gull	Nesting usually occurs on islands, but also on mainland peninsulas, isolated beaches, manmade spits, at landfill, etc. (Peck and James 1983); on islands, it usually nests on bare granite or limestone, occasionally in areas of gravel or sparse grasses or weeds (Peck and James 1983); at mainland sites, it usually nests among vegetation on gravel, sand, or rock (Peck and James 1983); tends to avoid areas of dense vegetation and completely bare sandy soil (Blokpoel and Tessier 1986); recently adapted to nesting on flat roofs (Blokpoel et al. 1990; Dwyer et al. 1996); nests are a raised mound of grasses, plant stalks, aquatic vegetation, twigs, feathers, and fish bones (Blokpoel and Tessier 1986; Peck and James 1983, 1994); nests are usually very near water; nests are reused year after year (Southern and Southern 1979); defends a territory of 1 to 4 m2 (Blokpoel and Tessier 1986); eats mostly earthworms and insects, as well as garbage, but also eats fish when they are readily available (Haymes and Blokpoel 1978; Johnston 1986; Kirkham and Morris 1979).
Herring Gull	Nests mostly on rocky islands or small islets, occasionally on mainland in disturbed areas with limited vegetation (Peck and James 1983); recently adapted to nesting on flat roofs (Blokpoel et al. 1990; Blokpoel and Smith 1988); prefers islands 0.1 to 6 ha in area (Timoney et al. 1985); usually nests very close to water (Peck and James 1983); nests are raised mounds on flat ground built of vegetation, twigs, mud, feathers, and bones (Peck and James 1983); rarely nests in trees (Peck and James 1983); prefers sparsely vegetated areas over bare areas, but avoids densely vegetated areas (Hogg and Morton 1983; Pierotti 1982; Ryder and Carroll 1978); nests are reused (Hogg and Morton 1983; Morris and Chardine 1985; Ryder and Carroll 1978); defends a territory of 9 to 460 m2 (Schoen and Morris 1984); eats mostly fish, but is a very opportunistic feeder (Blokpoel and Weseloh 1999; Fox et al. 1990; Hebert et al. 2000; Weseloh et al. 1999).

Great Black-backed Gull	Inland breeding occurs on small islands and rocky Islets of freshwater lakes and rivers and in a variety of habitats, including bare rock, shrub margins, marshes and dunes (Good 1998). Prefers sites on rock outcrop or pinnacle, sometimes near prominent feature; major requirements appear to be area free of (or inaccessible to) terrestrial predators, e.g., islands (Good 1998); breeds in many areas with Herring Gulls and Ring-billed Gulls; requires relatively large territory and rarely nests more closely than 2-3 pairs per colony site (Weseloh 2007); coloniality appears to be facultative as many Great Black-backed Gulls nest solitarily or in loose colonies (Good 1998).
Little Gull	Nests in marshes associated with large water bodies such as the Great Lakes (Ewins and Weseloh 1999; Weseloh in Cadman et al. 1987), occasionally on small ponds (Carpentier 1986; McRae 1984); nests are floating or semi-floating mats of aquatic vegetation, or they may be on muskrat houses; usually nests are in open water, occasionally among sedges or cattails (Carpentier 1986; Ewins and Weseloh 1999; McRae 1984; Peck and James 1983; Scott 1963); usually nests in water 20 to 70 cm deep (Peck and James 1983).
Caspian Tern	Nests mostly on isolated, sparsely vegetated islands or shoals, but also on manmade spits (Blokpoel and Scharf 1991; Blokpoel and Tessier 1991; Dobos et al. 1988; Peck and James 1983); recently adapted to nesting on manmade floating rafts (Lampman et al. 1996); nests mostly on limestone, granite, gravel, or sand with no or very little vegetation (Peck and James 1983; Weseloh and Blokpoel 1993); most nests are built of grass and dead vegetation (Peck and James 1983); successful breeders usually return to the same colony, but there is much movement among colonies (Blokpoel and Scharf 1991; Cuthbert 1985; 1988; L'Arrivée and Blokpoel 1988; Struger and Weseloh 1985); stable colony sites may be used for decades or centuries (Blokpoel and Scharf 1991); defends a territory of 1 to 2.5 m2 (Ludwig 1965; Martin 1978) eats fish almost exclusively (Cuthbert and Wires 1999); nests are almost always immediately adjacent to a good food source (Cuthbert and Wires 1999).
Common Tern	Nests mostly on sparsely-vegetated islands in large lakes, less frequently on shorelines and peninsulas, rarely in marshes (Peck and James 1983); prefers islands 0.1 to 20 ha in area (Nisbet 2002); most nests are on rock, sand, or gravel with sparse vegetation or among driftwood (Peck and James 1983); recently adapted to nesting on manmade floating rafts (Blokpoel and Weseloh 1999; Morris et al. 1992); nests may be reused and birds tend to return to the same colony or even same nest, but may move as far as 60 km to another colony (Austin 1951; Burger and Gochfeld 1991; Haymes and Blokpoel 1978; Ludwig 1962; Nisbet 1973); defends a territory of 0.5 m2 (Burger and Gochfeld 1991; Erwin 1988; Nisbet 2002) eats fish almost exclusively (Nisbet 2002); usually nests immediately adjacent to a good food source (Nisbet 2002).

From Index #7: Waterfowl Stopover and Staging Areas

The various waterfowl species have slightly different habitat requirements while they are at a migration stopover. The following table summarizes these habitat characteristics:

Species	Habitat Characteristics
Tundra Swan	In spring, congregates along the shorelines of the lower Great Lakes; also occurs in smaller numbers on inland lakes and ponds, as well as spring-melt areas in agricultural fields (Knapton 1997; Petrie and Wilcox 2001); eats mostly aquatic submergents taken from water as deep as 0.5 m, also eats roots and stems of emergents and agricultural crops such as corn, grain, and soybeans (Limpert and Earnst 1994).
Snow Goose	Usually flies directly to the breeding areas in spring with no concentrations in staging areas (Bellrose 1980; Blokpoel 1974; Gauthier et al. 1976); in autumn, stages in large numbers on islands and tidal flats in southern James Bay (Bellrose 1980; Cooch 1955; Cooke et al. 1975; Wypkema and Ankney 1979); some stopover in the south, usually in large marshes or lakes; often in the company of Canada Geese; eats mostly shoots and tubers of aquatic plants during migration, but some have adapted to feeding on agricultural crops (Abraham and Jeffries 1997; Wypkema and Ankney 1979).
Canada Goose	Limited staging occurs in spring, mostly at Lake St. Clair, Long Point, and the Detroit River (Dennis and Chandler 1974); in autumn, primary staging areas are lakes, ponds, marshes, and agricultural fields (Sandilands 2005); feeds mostly on waste grains and grasses (Mowbray et al. 2002).
American Green-winged Teal	Uses ponds, marshes, lakes, and watercourses during migration (Johnson 1995); eats mostly aquatic vegetation in shallow water or on mudflats (Nummi 1993); occasionally feeds in agricultural fields in autumn (Johnson 1995; Tamisier 1976).
American Black Duck	Prefers extensive marshes with nearby agricultural fields (Dennis et al. 1985; Ross 1985a; 1985b); smaller numbers may occur on beaver ponds and watercourses; eats mostly aquatic invertebrates and vegetation (Reinecke and Owen 1980; Ringelman et al. 1982), but also occasionally feeds in agricultural fields (Dennis et al. 1985).
Mallard	Prefers ponds and marshes with sparse or moderate vegetative cover (Godin and Joyner 1981); important habitat features are abundance and variety of aquatic plants, proximity of grain fields, off-shore loafing areas, and the presence of wide, shallow, littoral areas (Godin and Joyner 1981); extensive marshes adjacent to grain and corn fields are optimum habitat; in spring also uses meltwater ponds in agricultural fields (Dennis and Chandler 1974; Dennis et al. 1985; Ross 1985b); in spring, eats mostly invertebrates and aquatic vegetation; in autumn, eats mostly corn and grain; extensive field feeding seldom occurs near marshes smaller than 20 ha, and it prefers fields immediately adjacent to wetlands (Clark and Sugden 1990; Sugden and Driver 1979, 1980).
Northern Pintail	In spring, uses flooded fields and low-lying areas along watercourses; in autumn, it is associated with large marshes and fields; often field feeds with Mallards (Austin and Miller 1995).

Blue-winged Teal	In spring, occurs on small ponds, marshes, ditches, and slow-flowing streams (Sandilands 2005); prefers areas with emergent vegetation; seldom occurs in large numbers in spring (Sandilands 2005); in autumn, large flocks are associated with large marshes, but smaller numbers may occur on ponds and streams (Rohwer et al. 2002); eats mostly invertebrates and plant seeds; does not normally feed on crops (Rohwer et al. 2002; Sandilands 2005).
Northern Shoveler	Seldom occurs in flocks in spring, may be more common in autumn (Speirs 1985); prefers shallow ponds and marshes where there is vegetation floating on the water (DuBowy 1996; Ross 1985a; Sowls 1955); eats wetland plants and weeds that have been flooded (Sowls 1955).
Gadwall	Prefers large, deep-water marshes with an abundance of aquatic submergents such as pondweeds and water-milfoil (Sandilands 2005; Sousa 1985); eats mostly aquatic invertebrates in spring and leaves and stems of aquatic submergents in autumn (Sousa 1985); occasionally field feeds (Hochbaum 1944).
American Wigeon	Prefers large (>20 ha) marshes and open water bodies; eats mostly the foliage of submergent aquatic macrophytes (Joyner 1980; Mowbray 1999a; Ross 1985a; 1985b); occasionally feeds in grain fields (Bellrose 1980; Mowbray 1999a).
Canvasback	Occurs primarily in large marshes on the lower Great Lakes (Long Point, Turkey Point, Walpole Island, Lake St. Clair, Detroit River, Rondeau Bay); occasionally appears in smaller numbers on large, inland marshes and lakes (Dennis and Chandler 1974; Dennis et al. 1985); prefers deep-water marshes with an abundance of the submergent plants that it feeds on (Dennis et al. 1985; Dennis and North 1985; Mowbray 2002).
Redhead	Associated mostly with large marshes on the lower Great Lakes (Lake St. Clair, Walpole Island, Detroit River, Long Point, Turkey Point, Presqu'ile Bay, Bay of Quinte); also occurs on large inland lakes and marshes (Dennis and Chandler 1974; Dennis et al. 1985); prefers open water with an abundance of submergents, particularly pondweeds; feeds on submergents (Dennis and North 1985; Dennis et al. 1985; Woodin and Michot 2002).
Ring-necked Duck	Largest concentrations are in marshes on the lower Great Lakes, but it is also common on inland lakes, ponds, marshes, and watercourses (Hohman and Eberhardt 1998); eats mostly pondweeds, bulrush tubers, and bur-reeds, plus snails, clams, and aquatic insects (Hohman and Eberhardt 1998; Mendall 1958; Thompson 1973).
Greater Scaup	Most staging is on the Great Lakes, but it also occurs on large inland lakes, marshes, and rivers; rafts in open water bodies, but the presence of suitable emergents or aquatic invertebrates for food is essential (Dennis and Chandler 1974; Dennis et al. 1985); may also feed on zebra mussels (Wormington and Leach 1992).
Lesser Scaup	Habitat and diet are similar to the Greater Scaup; both species often stage together; eats zebra mussels, fingernail clams, amphipods, isopods, fly larvae, and fish while staging in Ontario (Custer and Custer 1996; Hamilton et al. 1994; Petrie 1999; Wormington and Leach 1992).

Common Goldeneye	Occurs on large rivers, inland lakes and marshes, and the Great Lakes; prefers areas with aquatic vegetation, but also uses areas devoid of vegetation (Dennis and Chandler 1974; Dennis et al. 1985); eats mostly aquatic insects, crustaceans, and molluscs, but also aquatic plants (Eadie et al. 1995); in Ontario also eats zebra mussels, amphipods, and snails during migration (Custer and Custer 1996; Hamilton et al. 1994; Wormington and Leach 1992).
Bufflehead	Flocks prefer large rivers, marshes, and lakes, but individuals or pairs may use very small ponds; prefers open water with a sand substrate and limited aquatic vegetation (Dennis and Chandler 1974; Dennis et al. 1985; Ross 1985b); eats mostly aquatic insects but has adapted to eating zebra mussels in Ontario during migration (Custer and Custer 1996; Hamilton et al. 1994; Knapton 1997; Wormington and Leach 1992); in some areas seeds of pondweeds and bulrushes may be important autumn foods (Gauthier 1993).
Hooded Merganser	Seldom occurs in large numbers; prefers small ponds, marshes, lakes, and medium-sized watercourses (Ross 1985b); eats mostly aquatic insects, crayfish, and small fish (Bellrose 1980; McNicol et al. 1987; Palmer 1976).
Ruddy Duck	Restricted to large marshes and lakes, but may occasionally stopover on small water bodies and ponds in spring (Sandilands 2005); prefers deep water adjacent to emergents; feeds on clams, snails, aquatic insects, and aquatic vegetation (Brua 2002).
Wood Duck	Favours wooded habitats near slow moving or standing shallow waters with irregular shorelines containing coves and backwaters (Fielder 2000). Found in riparian habitats (creeks, rivers, and overflow), wooded swamps, bottomlands, and freshwater marshes, beaver and farm ponds, and temporary and permanent wetlands (Hepp and Bellrose 1995; Hartke and Hepp 2004). Swamps, marsh, and overflow areas may provide better habitat than streams, but the extensive distribution of streams and their riparian zones makes them critical habitat (Bellrose and Holm in Hepp and Bellrose 1995; Granfors and Flake 1999). Habitat use is thought to vary little across seasons and migrating birds use similar habitats as breeding birds (Hepp and Bellrose 1995). Preferred foraging habitat consists of flooded timber and shallow wetlands with scrub/shrub and emergent vegetation where water is 18–40 cm (Hepp and Bellrose 1995). When aquatic foraging habitat unavailable will forage in upland habitats for nuts and grain (Hepp and Bellrose 1995). Not typically found in large aggregations except at roosting areas in fall and winter; known to migrate in small groups (6–12 individuals) (Hepp and Bellrose 1995).
Common Merganser	Migratory habitats include shallow water feeding areas on rivers, large lakes, and reservoirs (Mallory and Metz 1999). However, can be found in coastal bays and estuaries while migrating (Pearce et al. 2005). Major rivers, lake chains, and coastlines provide a focus for migration movements (Mallory and Metz 1999). Freshwater habitats are preferred in winter (Mallory and Metz 1999). Forages in clear aquatic habitats including streams, rivers, and littoral zones of lakes, coastal bays, and estuaries (Mallory and Metz 1999); prefers feeding in water < 4 m deep (Alvo in Mallory and Metz 1999).

Surf Scoter	Primarily uses shallow unvegetated lakes less than 10 ha in size, (Décarie et al. 1995), avoiding rivers and large, deep lakes within its breeding range (Savard et al. 1998) Has been observed using lakes 10-100ha in size (Décarie et al. 1995). Frequents lakes usually that are saturated in oxygen and clear, and that have pH ranging from 5.1 to 7.0, low conductivity, and little emergent vegetation (Savard and Lamothe in Savard et al. 1998). Uses rocky-shored lakes and ponds of western boreal forest/ tundra zone (Goudie et al. in Savard et al. 1998). Rarely found in solitary pairs, usually forms large feeding groups (Savard et al. 1998). During spring and fall migration, found in coastal estuaries, inshore ocean areas, and occasionally freshwater habitats near ocean (Savarad et al. 1998). Environments with higher salinity are preferred (Zydelis et al. 2006), for example lower part of estuaries preferred to more brackish upper. Prefers coastal sandy substrates, but also found on rocky substrates (Zydelis et al. 2006).
Long-tailed Duck	Uses subarctic and arctic wetlands in breeding range, rarely to tree line and is occasionally found in tundralike habitats at higher altitudes (Robertson and Savard 2002). Generally migrates close to shore, but may also migrate offshore, following ice leads (Johnson and Richardson in Robertson and Savard 2002). Uses coastal lagoons for staging and moulting; in Ontario, James Bay and Hudson Bay offer many important staging ground for the species (Mallory et al. 2006); in the Beaufort sea, barrier lagoon systems are important habitats (Johnson et al. 2005). Prefer deep and open lakes with steep rocky headlands (Mallory et al. 2006; Robertson and Savard 2002).
Brant	Breeds from the low Arctic to the high Arctic, and migrates long distances to wintering areas, often flying non-stop for large portions of the route (Reed et al. 1998) For example, Atlantic Brant often fly non-stop from James Bay Long Island, New York in the Fall. Return migration involves a couple of stops with birds taking one of two routes, either along the coastal route through New England and Maritime Provinces into St. Lawrence Gulf and Estuary, or overland towards the confluence of Ottawa and St. Lawrence Rivers (Erskine in Reed et al. 1998), both groups eventually meet up at James Bay. Most important staging areas found in shallow marine waters along indented shorelines, within lagoons, or behind barrier beaches, where most are characterized by presence of tidal or subtidal eelgrass meadows (Reed et al. 1998; Moore and Black 2006). Eelgrass is the preferred staging habitat for Brant (Reed et al. 1998; Moore and Black 2006). Extensive beds of seagrass occur along the highly indented northeastern coast of James Bay. Tidal and subtidal flats with abundant green algae or salt marshes with cordgrass are also used (Reed et al. 1998). Subarctic salt marshes occur in western James Bay, which is a major staging area (Reed et al. 1998).
White-winged Scoter	Migrates from saltwater habitat to inland freshwater habitat in Spring, using estuaries and open coastal habitats, then large lakes and rivers when moving inland and vice versa when moving to the coast in the Fall. Nests on large freshwater lakes (>45 ha with large area between 1-4m in depth) (Brown and Brown 1981), wetlands, or permanent ponds, with highest densities occurring on lakes with islands covered in dense vegetation (Brown and Fredrickson 1997). Favours foraging in large wetlands and lakes, either brackish or freshwater sites (Brown and Fredrickson 1997).

Black Scoter	Migrates from saltwater habitat to inland freshwater habitat in Spring (Bordage and Savard 1995). For breeding purposes, prefers lakes less than 10 ha but will use lakes up to 100 ha in size (Décarie et al. 1995). In northern Quebec, generally uses lakes 10–30 ha, which are relatively shallow (< 5 m), and located on a gross till or rock substrate; rivers and large, deep lakes are avoided (Bordage and Savard 1995). Frequented lakes are usually saturated in oxygen, clear, acidic (pH > 5), low conductivity, with little emergent vegetation (Savard and Lamothe in Bordage and Savard 1995). Large molt migrations occur from the breeding grounds, with sites identified in James and Hudson Bays (Bordage and Savard 1995). In eastern James Bay, molting individuals frequent underwater plateaus with water depths 1–6 m to feed on mollusks (Benoit et al. in Bordage and Savard 1995).
Red-breasted Merganser	Found in the tundra and boreal forest zones inhabiting: coastal bays; large water bodies or rivers; and fresh, brackish, and saltwater wetlands with sheltered bays, typically not far from sea coast. (Titman 1999). In Britain study found preference for wider rivers with slow smooth river sections (Gregory et al. 1997); in Norway study found use of fast-flowing rivers with few calm stretches (Råd in Titman 1999). Prefers lakes with steep shorelines and depths of 4 to 55 m (Weller in Titman 1999).In coastal areas, often observed at river mouths where it equally utilises the shallower estuarine subtidal seagrass beds and deeper estuarine subtidal unconsolidated bay bottom (Gibbons and Withers 2006). Heavily utilizes floating seaweed patches where it forages for small fish on the ocean (Vandendriessche et al. 2007).
Common Loon	Prefers oligotrophic lakes (with fish) surrounded by forest, with rocky shorelines, deeply indented bays, numerous islands, and floating bogs; characteristic of boreal and mixed forest overlying Precambrian shield (Barr 1996). Stages on rivers and larger lakes (including Great Lakes) and reservoirs with ample food (McIntyre and Barr 1983; Kenow et al. 2002). Concentrations of individuals found in early spring on inlets/outlets where open water is available (Mcintyre and Barr 1997). Territories often occupied before they are ice-free (Mcintyre and Barr 1997). Known to stage in coastal environments in favorable habitats that combine abundant food and shelter from waves (Mcintyre and Barr 1997); prefer deeper estuarine subtidal unconsolidated bay bottom (Gibbons and Withers 2006). Plankton blooms attract schooling fish which Common Loon feeds upon (Mcintyre and Barr 1997).
Red-throated Loon	Stages on large lakes, including several of the Great Lakes (Barr et al. 2000). Lake Ontario is a particularly important staging area (Sherony et al. 2000); thousands are known to congregate (Palmer in Barr et al. 2000; Sherony et al. 2000). Inland follows large bodies of water toward Atlantic Coast wintering sites and vice versa to nesting grounds in the spring (Paxton et al. in Barr et al. 2000). Found mainly on remote ponds in coastal tundra habitat during summer (Barr et al. 2000). Forages away from nesting pond, often flying to larger lakes or the sea (tidal estuaries) to feed and carry single fish back to its young (Barr et al. 2000).

Red-necked Grebe	Stages on ocean coastlines, large lakes (especially Great Lakes), and occasionally rivers on route to and from winter range (Stout and Nuechterlein 1999). Principle fall migration route is via Great Lakes, especially Superior (is major diurnal passage), Huron, and Ontario; smaller numbers move through Lakes Michigan and Erie, St. Lawrence River, and inland areas south and east of Great Lakes (Stout and Nuechterlein 1999). Migratory routes in spring similar fall, but greater numbers are observed on Lake Ontario, and diurnal passage by Lake Superior is less. Lake Ontario important as spring stopover area (Speirs in Stout and Nuechterlein 1999). Known molting areas are on route to wintering areas; Manitoulin Island in northern Lake Huron has been identified as an important molting area (Stout and Cooke 2003). Estuarine or coastal waters that are used often located in inlets and bays, but also over shallows located well offshore (Stout and Nuechterlein 1999).
American Coot	Can be found staging in a variety of wetlands, including freshwater lakes, ponds, marshes, roadside ditches, and industrial-waste impoundments, as well as in coastal marine habitats such as estuaries and mudflats (Brisbin et al. 2002). Two features characterize all bodies of water used: (1) heavy stands of emergent aquatic vegetation along at least some portion of the shoreline and (2) at least some depth of standing water within those stands of vegetation (Brisbin et al. 2002). In coastal areas, prefer shallower estuarine subtidal seagrass beds Gibbons and Withers 2006). In Oklahoma, fall migrants initially selected open water areas, and after 6 days moved to habitats characterized by greater vegetative cover, shallower water, higher alkalinity, lower pH, and higher conductivity (Eddleman in Brisbin et al. 2002); during spring migration, used smaller wetlands (Heitmeyer in Brisbin et al. 2002).

From Index #8: Shorebird Migratory Stopover Areas

The following table summarizes some of the habitat characteristics of migrating shorebirds. For the sake of completeness, some species that may prefer wet fields to shorelines have been included, as some shorelines may have suitable habitat for them. Information on the timing of migration in the south is provided.

Species	Habitat Characteristics
Black-bellied Plover	Spring migration is from late April until early June (Bradstreet et al. 1977; Weir 1989); autumn migration is from late July to early November (males migrate first, then females, and finally juveniles) (Bradstreet et al. 1977; Strahlendorf 1979; Weir 1989); prefers shoreline mudflats and sand beaches, occasionally uses rocky shorelines (Burger et al. 1977; Colwell and Oring 1988; Hicklin 1987; Pittaway 1999; Wishart et al. 1981); also uses wet pastures and ploughed fields (Pittaway 1999; Strahlendorf 1979); rarely ventures deeper than 30 cm into the water or farther than 3 m from shore (Recher 1966); prefers emerged mudflats and substrate with aquatic vegetation or algae (Paulson 1995; Recher 1966); eats fly and beetle larvae, earthworms, a variety of adult insects, and plant seeds (Baker 1974; Hicklin 1987; Hussell and Page 1976; Paulson 1995; Recher 1966; Schneider and Harrington 1981; Wishart et al. 1981).

American Golden Plover	Spring migration is in the last half of May (Weir 1989) and birds often fly directly to the breeding grounds without stopping over (Parmelee et al. 1967); autumn migration is from mid-August to the end of October (Allin 1945; Johnson and Connors 1996; Pittaway 1999; Strahlendorf 1979; Weir 1989); prefers drier areas, particularly rocky or gravelly areas; more likely to occur in upland habitats away from shorelines (Allin 1945; Brooks 1967a; Colwell and Oring 1988; Hicklin 1987; Strahlendrof 1979; Wishart et al. 1981); at shorelines, forages near the water or in adjacent upland areas (Recher 1966); rarely ventures into the water (Recher 1966); eats insects, molluscs, and crustaceans during migration (Brooks 1967b; Johnsgard 1981).
Semipalmated Plover	Spring migration is from mid-April until the end of May (Bradstreet et al. 1977; Lancaster et al. 2004; Weir 1989); autumn migration is from mid-July until mid-October (Bradstreet et al. 1977; Nol and Sullivan Blanken 1999; Weir 1989); prefers mud and sand substrates, but will use gravel and rocks (Brooks 1967a; Burger et al. 1977; Campbell et al. 1990; Colwell and Oring 1988; Hicklin 1987; Recher 1966; Strahlendorf 1979); feeds at the water's edge or in backshore areas (Recher 1966); almost never ventures into the water (Recher 1966); feeds on algae and a wide variety of invertebrates (Baker 1977; Brooks 1967a; Nol and Sullivan Blanken 1999; Recher 1966; Reeder 1951).
Greater Yellowlegs	Spring migration is from early April to early May (Bradstreet et al. 1977; Elphick and Tibbitts 1998; Lancaster et al. 2004; Weir 1989); autumn migration is from mid-July to late October (Bradstreet et al. 1977; Weir 1989; Weir and Cooke 1976); prefers shallow water over mud (Hope and Shortt 1944); seldom uses sand beaches and prefers ponds, open marshes, sloughs, wet meadows, sewage lagoons (Bradstreet et al. 1977; Colwell and Oring 1988; Hicklin 1987; Pittaway 1999; Weir 1989); usually feeds in the water to a depth of 15 cm (Recher 1966); eats aquatic insects, small fish, and amphibians (Barnett and Brewer 1971; Brooks 1967a; 1967b; Elphick and Tibbitts 1998; Johnsgard 1981; Reeder 1951).
Lesser Yellowlegs	Spring migration is from early April to late May (Bradstreet et al. 1977; Lancaster et al. 2004; Tibbitts and Moskoff 1999; Weir 1989); autumn migration is from early July until mid–November (Bradstreet et al.,1977; Pittaway 1999; Weir 1989; Weir and Cooke 1976); has the same habitat preferences as the Greater Yellowlegs (Bradstreet et al. 1977; Campbell et al. 1990; Hicklin 1987; Johnsgard 1981; Pittaway 1999; Strahlendorf 1979; Tibbitts and Moskoff 1999); forages in water mostly on small crustaceans, but will eat a wide variety of invertebrates (Baker 1977; Brooks 1967a; 1967b; Michaud and Ferron 1990; Tibbitts and Moskoff 1999).
Ruddy Turnstone	Spring migration is in the last half of May and early June (Bradstreet et al. 1977; Weir 1989); autumn migration is from mid-July until early October (Bradstreet et al. 1977; Pittaway 1999; Weir 1989; Weir and Cooke 1976); prefers rocky shorelines and pebbly beaches (Bradstreet et al. 1977; Burger et al. 1977; Campbell et al. 1990; Hicklin 1987; Strahlendorf 1979; Weir 1989; Wishart et al. 1981); feeds above the shoreline, often about 10 m away (Bradstreet et al. 1977; Burger et al. 1977); feeds by flipping over stones or by rooting like a pig; feeds mostly on invertebrates, but is very opportunistic (Gochfeld and Burger 1980; Johnsgard 1981; Strahlendorf 1979; Sullivan 1986; Wishart et al. 1981).

Sanderling	Spring migration is mostly in the last half of May (Bradstreet et al. 1977; James 1991; LaForest 1993; Weir 1989); autumn migration is from mid-July to late October (Bradstreet et al. 1977; Hicklin 1987; James 1991; Weir 1989; Weir and Cooke 1976); prefers sandy beaches (Bradstreet et al. 1977; Burger et al. 1977; Connors et al. 1981; Hicklin 1987); feeds at the shoreline (Recher 1966), mostly on crustaceans and clams, but also on other invertebrates (Connors et al. 1981; Gochfeld and Burger 1980; Johnsgard 1981; Reeder 1951); roosts on logs or rocks higher up on the shoreline.
Semipalmated Sandpiper	Spring migration is mostly in the last week of May and first week of June (Gratto-Trevor 1992; Harrington and Morrison 1979; Lancaster et el. 2004; Weir 1989); autumn migration is from mid-July to mid–October (Harrington and Morrison 1979; Lancaster et al. 2004; Weir 1989); prefers beach pools and sheltered beaches; prefers mud and very fine silt with some algae (Bradstreet et al. 1977; Brooks 1967a; Burger et al. 1977 Colwell and Oring 1988; Gratto-Trevor 1992); feeds mostly in water as deep as 2 cm; eats mostly aquatic invertebrates 4 to 6 mm long (Baker 1977; Brooks 1967a; 1967b; Hicklin and Smith 1984; Michaud and Ferron 1990).
Least Sandpiper	Spring migration is mostly in the last two weeks of May (Bradstreet et al. 1977; Weir 1989); autumn migration is from mid-July until late September (Bradstreet et al. 1977; Page and Bradstreet 1968; Pittaway 1999; Weir 1989; Weir and Cooke 1976); prefers damp, soft substrate near the shoreline or well above it (Bradstreet et al. 1977; Brooks 1967a; Campbell et al. 1990; Colwell and Oring 1988; Hicklin 1987; Page and Bradstreet 1968; Recher 1966; Wishart et al. 1981); rarely ventures into the water (Recher 1966); feeds in areas with algae mats (Recher 1966); eats aquatic insects, snails, and earthworms (Baker 1977; Brooks 1967a; Strahlendorf 1979).
White-rumped Sandpiper	Spring migration is in late May and early June (Bradstreet et al. 1977; James 1991; Weir 1989); autumn migration is late July until early November (Bradstreet et al. 1977; James 1991; Weir 1989; Weir and Cooke 1976); prefers mud, sand, and gravel substrates; roosts on high sandy beaches (Campbell et al. 1990; Hicklin 1987; Strahlendorf 1979; Weir 1989); feeds near the shoreline on aquatic invertebrates (Bent 1927; Drury 1961; Parmelee 1992).
Dunlin	Spring migration is mostly in the last half of May (Bradstreet et al. 1977; LaForest 1993; Weir 1989); autumn migration is from late September until early November (Bradstreet et al. 1977; Weir 1989; Weir and Cooke 1976); feeds at the shoreline in mud and sand; roosts above the water on logs and driftwood (Bradstreet et al. 1977; Campbell et al. 1990; Colwell and Oring 1988; Hicklin 1987; Holmes 1966; Recher 1966; Smith and Connors 1993; Warnock and Gill 1996); eats aquatic and terrestrial insects and snails (Brooks 1967a; 1967b).
Short-billed Dowitcher	Spring migration is mostly in May and early June (Bradstreet et al. 1977; Jaramillo et al. 1991; Jehl et al. 2001; Weir 1989); autumn migration is from late July until the end of September (Bradstreet et al. 1977; Jehl 1963; Jehl et al. 2001; Pittaway 1999; Weir 1989; Weir and Cooke 1976); avoids exposed beaches (Bradstreet et al. 1977); prefers mudflats (Bradstreet et al. 1977; Jehl et al. 2001; Recher 1966); forages at the water's edge or in water as deep as 30 cm (Burger et al. 1977; Recher 1966); eats aquatic insects, molluscs, crustaceans, small fish, and plant seeds (Jehl et al. 2001; Mallory and Schneider 1979; Reeder 1951; Schneider and Harrington 1981; Sperry 1940).

Wilson's Snipe	Begin arriving in southern Ontario in late March to early April (Peck 2007b); southbound movement begins in August and lasts at least into November (Mueller 1999); migrates at night; when not in flight, uses marshes (including cattails), swamps, wet meadows, wet pastures, wet fallow fields, and marshy edges of streams and ditches during spring and fall migration (Mueller 1999); eats mostly larval insects, but also takes crustaceans, earthworms and mollusks; foods are basically similar throughout range and seasons (Mueller 1999).
Marbled Godwit	Two known disjunct breeding populations occur in Ontario: Rainy River and James Bay (Abraham 2007); Marbled Godwits are rare migrants in Ontario; arrives in spring mid-May and leaves by mid-September (James 1991); during spring migration, uses a variety of wetland habitats; fall migrants use both wetlands and lake shorelines; on interior migratory staging areas, eats insects (particularly grasshoppers), aquatic plant tubers, leeches and small fish (Gratto-Trevor 2000).
Hudsonian Godwit	Hudsonian Godwits are considered rare to uncommon away from Hudson and James Bay coasts (James 1991); migrants likely make long, non-stop flights between breeding and wintering areas; in spring, most birds pass through the Great Plains with no concentrations reported for Ontario (Elphick and Klima 2002, James 1999); during fall migration, much of the Canadian breeding population stages in large flocks along the western James Bay coast, prior to migrating south to wintering sites in South America (Sutherland and Peck 2007); during migration, uses a variety of wetland habitats including estuarites, marshes, shallow ponds, mudflats, sandy shores, wet fields and sewage lagoons; eats mainly invertebrates and plant material; migrating birds may rely heavily on plant tubers at inland sites (Elphick and Klima 2002).
Solitary Sandpiper	Ucommon migrant in Ontario; arrives in early may and departs in late September (James 1991). Migrates mostly at night, either in small numbers or alone; avoids alkaline water conditions more than other shorebirds do; prefers enclosed wet or muddy habitats such as forested inland lakes and ponds, lakeshores, edges of wooded swamps, drainage ditches; eats insects, supplemented by small crustaceans, small mollusks and frogs (Moskoff 1995a).
Spotted Sandpiper	Common migrant in Ontario, arriving early May and departing late September (James 1991); migrates on broad front throughout the Americas, preferring inland freshwater habitats; usually migrates singly in spring and singly or in small groups in fall; migrates during day and at night; during migration and in winter, occurs anywhere there is water; eats freshwater and terrestrial invertebrates, and occasionally small fish (Oring et al. 1997).
Pectoral Sandpiper	Common to locally abundant migrant in Ontario, arriving in early April and departing in late October (James 1991); migrates in monospecific flocks of several hundred to ≥1,000, and sometimes flocks with other species (e.g., Dunlin, Semipalmated and Least Sandpipers); on the southward migration, adults have been recorded passing through Long Point mainly between mid-July and mid-August, with juveniles following later in September to early October (Holmes and Pitelka 1998); during migration, often found in sewage lagoons, wet grassy meadows, flooded fields and small marshy ponds (Peck 2007a); eats freshwater, marine, and terrestrial invertebrates, occasionally seeds and algae (Holmes and Pitelka 1998).

Baird's Sandpiper	Rare spring and uncommon autumn transient in Ontario, arriving in mid-May to early June and departing in August to mid-September (James 1991); the main population moves north and south through the centre of the continent, and relatively few (mainly juveniles) wander into the province (James 1999); during migration, prefers inland freshwater habitats such as river bars, lake and pond margins, ditches, irrigated or rain-soaked fields; eats inects almost exclusively, but also takes some spiders and pond crustacea (Moskoff and Montgomerie 2002).
Western Sandpiper	Rare to locally common spring and autumn transient in southern Ontario, arriving early May to early June and departing August to September (James 1991); at interior stop-over sites during migration, prefers habitat at the margins of lakes and ponds; on the breeding grounds and inland stop-over areas during migration, eats freshwater benthic invertebrates, adult insects and spiders (Wilson 1994).
Buff-breasted Sandpiper	Rare to locally uncommon spring and autumn transient in southern and western Ontario, arriving mid-May to early June and departing late July to mid-September (James 1991); most migrants move through the centre of the continent, and only singles or very small groups occur in southern Ontario (James 1999); migrates as singles or pairs, occasionally in flocks of ≤ 5; thought to be nocturnal migrants; tend to use the same fields from year to year; prefer short-grass areas such as pastures, golf courses, cemetaries, airports and lawns, damp margins of fresh-water lakes, ponds, and lagoons; spring spring migrants eat mostly terrestrial invertebrates (including spiders), insects (adults, larvae and pupae) and plant seeds; fall migrants observed eating copepods, crane-flies, and gammarid crustaceans (Lanctot and Laredo 1994).
Purple Sandpiper	Usually rare to locally uncommon autumn transient on Lake Ontario and the Hudson and James Bay coasts; occasional, rare spring transient; principal dates in Ontario are from late October to late December (James 1991); move mainly to the Atlantic coast from the eastern Arctic (James 1999); on migration, uses mainly exposed, rocky coastal shores with considerable wave action; tidal flats and muddy pools are also used; inland migrants (rare in North America) are usually found along rocky shores of large inland bodies of water, or along breakwaters or other natural or human-made rocky surfaces; during migration and in winter, eats mainly gastropods (especially Littorina and bivalves, e.g., mussels Mytilus sp.), insects (beetles and dipteran flies), crustaceans (amphipods), annelid worms and smaller amounts of aquatic vegetation (algae) (Payne and Pierce 2002).
Long-billed Dowitcher	Rare to locally uncommon transient; more usual in southern Ontario and in the autumn, when a few wandering birds turn up in the Great Lakes area (James 1999); arrives in Ontario between early and mid-May and departs from late July to late October (James 1991); usually migrates in single-species flocks, and some nocturnal migration has been documented (Takekawa and Warnock 2000); during migration and in winter, can be found on mudflats, marshes and at the edge of freshwater ponds (NatureWorks 2008, Terres 1980); non-breeding birds eat insects (Environment Canada 2005).

Wilson's Phalarope	Rare to locally uncommon migrant, arriving in Ontario late May and departing by late September (James 1991); large fall flocks of adults prepare for migration (stage) mainly in open, shallow-water habitats, especially at large hypersaline lakes of western Canada and the U.S.; spring migrants use shallow wetlands and coastal marshes, particularly in the south-central U.S.; throughout the staging period, females typically forage aquatically, spearing brine shrimp (Artemia spp.) and brine flies (Ephydra spp.) from water's surface; in contrast, males and juveniles are more terrestrial, early foraging on brine flies on or nearer lakeshore, later becoming highly aquatic and (males) taking more shrimp (Colwell and Jehl 1984).
Red Phalarope	Rare transient in southern Ontario in the fall, occurring from mid-September to mid-November (James 1991); migrates over the Atlantic Ocean between arctic breeding areas and winter range; occasionally occurs on freshwater bodies of the interior (Godfrey 1986); Environment Canada (2005) reports "no data" about food habits of non-breeding birds.
Red-necked Phalarope	Rare in spring to uncommon in the fall, arriving in late May and departing in late September (James 1991); most migrants probably overfly the province to the Atlantic, but some may stop far offshore on the Great Lakes (James 1999, Rubega et al. 2000); overland migrants use large and small interior lakes and ponds, marshes, shallow wetlands, flooded fields and sewage lagoons (Godfrey 1986, Rubega et al. 2000); inland migrants eat small invertebrates, especially copepods and aquatic larvae of flies (Rubega et al. 2000).
Whimbrel	Uncommon to locally abundant migrant, arriving in Ontario mid-May and departing mid-September (James 1991); many seen on northern coasts of Lakes Erie and Ontario in late May; Lake Ontario shores are key habitats for northbound migrants, which tend to move in groups of about 50-100, but sometimes as many as 2,000-3,000 (James 1999); occasionally sighted in Great Lakes from mid-Jul to mid-Oct; during fall migration, uses a variety of terrestrial and coastal habitats, including ericaceous heaths, meadows, fields, intertidal flats, sandy beaches, rocky shores, river mouths and estuaries, salt marshes, lagoons, and upper beaches and dunes; diet during migration is broad, including marine crabs and other crustaceans, marine worms, molluscs and fish (Skeel and Mallory 1996).
Killdeer	Common migrant in Ontario, arriving in mid-March and departing in late October (James 1991); migrates during the day and at night, generally in flocks of 6-30 birds; preferred stopover and feeding habitats include mudflats left by receding floodwaters and human-made wetlands such as sewage lagoons and reservoirs, and gravel bars in rivers, fallow agricultural fields, and broad expanses of open, closely mowed grassy areas such as sod farms and golf courses (particularly when wet); eats terrestrial invertebrates, especially earthworms, grasshoppers, beetles, and snails; infrequently takes small vertebrates and seeds (Jackson and Jackson 2000).
Red Knot	Uncommon to locally abundant spring and fall transient in Ontario; recorded in spring in mid- to late May and in the fall in September (James 1991); most birds leave northern breeding areas in the fall and fly right over Ontario, but groups of tens to a few hundreds may be seen, mainly on the Great Lakes (James 1999); Red Knots are transoceanic migrants, generally preferring sandy coastal habitats at or near tidal inlets or the mouths of bays and estuaries; also use tidal flats in more sheltered bays or lagoons; during the non-breeding season, Red Knots eat benthic invertebrates (especially bivalves), small snails, crustaceans (Harrington 2001). Note that the rufa subspecies of Red Knot is listed as endangered, and protected under Ontario's Species at Risk Act.

From Index #13: Reptile Hibernacula (terrestrial)

The following table summarizes the general habitat requirements of species in this guild.

Species	Habitat Characteristics
Eastern Garter Snake	Moist areas, stream and swamp borders, bogs or marshes; wood edges or fencerows, vacant lots, hibernates in holes, crevices, anthills, mud, rotted wood, uprooted trees, or house foundations; hibernates in groups.
Brown Snake	Urban or rural areas, vacant lots or trash piles, parks or damp mixed or deciduous woods, swamps or wet meadows, clearings, cultivated lands, pastures or open fields, hides under stones, banks, logs, brush or leaf piles; hibernates in groups or ant hills or abandoneded mammal burrows.
Smooth Green Snake	Grassy open fields or medows, open aspen stands other hardwood stands, sphagnum bogs or marshes: found in vines, brambles: nest sites may be used by several females.
Northern Ringneck Snake	Moist shady woodlands with lots of cover, stony woodland pasture, shrubby old fields, under rocks, logs or debris and in stone walls or old junk piles. Eggs are laid in or under logs or stones; several females may use the same nest.
Northern Water Snake	Near rivers, brooks, wet meadows, ponds, swamps, bogs or old quarries, around spillways and bridges; uses branches or logs overhanging water and emergent boulders for basking.
Eastern Milksnake	Farmlands, meadows, hardwood or aspen stands, pine forest with brushy or woody cover, river bottoms or bog woods, hides under logs, stones, or boards or in outbuildings; often uses communal nest sites.
Northern Ribbonsnake	Sunny grassy areas with low dense vegetation neatr bodies of shallow permanent quiet water, wet meadows, grassy marshes or shaghnum bogs, borders of ponds, lakes or streams; hibernates in groups.
Northern Red-belly Snake	Moist woods and hillsides, woodlands with pine, oak-hickory, apsen or hemlock groves; occasionally in sphagnum bogs, shrubby swamps, marches and wet meadows, river valleys; debris and abandones buildings.
Five-lined Skink	Moderately, dense or open deciduous or mixed woodlands with logs and slash piles: damp spots under logs, leaf litter or sawdust, open talus slopes, barren rock, sandy beaches of Lake Erie, Lake Ontario, breeds in forest floor litter, lays, protects eggs under rocks, logs, forages in open woodlands, in sandy areas, along shores of lakes and islands; hibernates under rock piles, in rock crevices, under logs and in stumps.

From Index #14: Amphibian Breeding Habitat (Woodland) and Index# 40: Amphibian Movement Corridors

The following table summarizes important habitat requirements and chronology of amphibians that breed in woodland pools. For many of the mole salamanders that breed early in the spring, the presence of some green algae is important. The algae provide oxygen which is essential in the development of the eggs. This may also be an important factor for some other groups of amphibians.

Species	Habitat Characteristics
Bull Frog	Live in deep, permanent water with abundant emergent plants; requires stable water levels, particularly during winter hibernation and summer spawnging periods.
Eastern (red-spotted) Newt	Breeds in permanent ponds (Bishop 1943), usually with dense submergent vegetation but occasionally in ponds with limited aquatic vegetation (Bishop 1941; Lamond 1994); breeding may also occur in swamps, roadside ditches, and in slow-flowing streams (Bishop 1943); breeding ponds are usually within or a short distance from forests, but occasionally they are in the open and considerable distance from forest habitat (Bishop 1943; Lamond 1994); breeds from April to June with adults that were aquatic over winter breeding earlier than those that wintered on land (Johnson 1989; Lamond 1994; Logier 1952); eggs are attached singly to submergent vegetation or rarely to stones (Bishop 1943) and hatch in 20 to35 days (Bishop 1943); the larval period lasts 2 to 3 months (Bishop 1943); transform into red efts that move out into the forest and also into adjacent open habitats.
Blue-spotted Salamander	Breeds in a wide variety of forest cover including deciduous, mixed, and coniferous upland and lowland stands (Lamond 1994); also breeds in ponds, marshes, and roadside ditches away from forest (Lamond 1994); breeding coincides with the first spring rains in March or early April, often before the pond is completely ice free (Lamond 1994); lays eggs singly or in pairs on leaves or other litter on the bottom of the pond (Lamond 1994); occasionally lays eggs in small clumps of 4 to 9 eggs and attaches the egg mass to a twig, similar to the egg laying habits of the Tremblay's salamander (Lamond 1994); eggs hatch in 3 to 4 weeks, and larvae begin to transform in mid July, occasionally as early as late June (Lamond 1994); complete transformation may take until early August (Lamond 1994); adults leave the pond shortly after breeding, young leave as soon as they transform (Lamond 1994); adults remain in forest habitat and hide under logs or burrow in the soil, some wander out into open habitat (Lamond 1994).
Spotted Salamander	Prefers well-drained, upland deciduous and mixed forests with or adjacent to permanent or temporary pools (Lamond 1994); breeds very early in the spring, occasionally before ice is totally gone (Lamond 1994), usually when air temperatures exceed 5°C and there is nocturnal rainfall (Tyning 1990); eggs are laid in masses on twigs and branches in the pond (Lamond 1994); hatching period and larval transformation time is highly dependent on water temperature (Bishop 1943; Lamond 1994); hatching takes 39 to 54 days, and transformation another 61 to 113 days (Bishop 1943); overwintering of larvae has been reported from other areas (Whitford and Vinegar 1966), but has not been reported in Ontario (Lamond 1994); adults leave the pond shortly after breeding, young leave as soon as they transform (Lamond 1994); adults remain in forest habitat and hide under logs or burrow into the soil (Lamond 1994).

American Toad	Breeds in temporary and permanent woodland pools, plus a wide variety of other habitats: marshes, ditches, open ponds, manmade ponds, tire ruts, and pools in agricultural and urban areas (Lamond 1994); has the widest breeding niche of Ontario's amphibians (Lamond 1994); prefers to breed in ephemeral pools but also breeds in permanent waters (Lamond 1994); breeds around mid-April until early May in the south (Lamond 1994); lays eggs in two strands which are wrapped around plants, rocks, and twigs (Wright and Wright 1949); eggs hatch in 3 to 12 days depending on water temperature (Wright and Wright 1949); tadpoles transform in 50 to 65 days, and young often leave the pond before the end of June (Lamond 1994; Wright and Wright 1949); adults may remain in forest habitat or move to open areas such as fields and residential areas (Lamond 1994; Wright and Wright 1949).
Gray Treefrog	Breeds in a wide variety of habitat including swamps, marshes, farm ponds, flooded farmland, and floodplains (Lamond 1994); uses temporary and permanent pools (Lamond 1994); breeding occurs from mid-May until early July (Lamond 1994); eggs are laid as floating packets and hatch within 5 days (Wright and Wright 1949); tadpoles take 40 to 60 days to transform into adults, with transformation usually occurring in late July or early August (Lamond 1994; Wright and Wright 1949); adults are arboreal and may remain in forest habitat or move to shrublands or rural residential areas (Lamond 1994).
Spring Peeper	Breeds mostly in pools in second growth forests or swamps, but also in isolated ponds with margins of emergents or shrubs (Lamond 1994); prefers ponds where there are trees or shrubs along the shoreline, but also uses areas of herbaceous emergents (Lamond 1994); egg-laying starts in late March or early April in the south (Lamond 1994); eggs are laid singly or in small groups on submerged twigs and leaves (Wright and Wright 1949); egg hatching takes about 15 days, depending on water temperature (Lamond 1994; Wright and Wright 1949); transformation takes 90 to 100 days, usually during the last half of June (Lamond 1994; Wright and Wright 1949); most adults remain in forest habitat, but some move to more open areas (Johnson 1989; Lamond 1994; Logier 1952).
Chorus Frog	Prefers shallow, temporary pools with abundant vegetation for breeding, but will occasionally use permanent ponds (Lamond 1994; Logier 1952; Wright and Wright 1949); breeds in woodlands, but also in disturbed habitats such as agricultural areas, shrublands, and meadows (Lamond 1994); in the Hamilton area, was more common in the southern portion of the area where there is less forest cover (Lamond 1994); requires areas with emergent or floating aquatic vegetation (Johnson 1989); breeding begins very early in the spring, often in late March and always by early April in the south (Lamond 1994); eggs are laid in small masses on submerged twigs (Logier 1952); egg hatching takes about 2 weeks depending upon water temperatures (Logier 1952); transformation is rapid (40 to 90 days) (Wright and Wright 1949) and may begin by the end of June (Logier 1952); adults usually remain in wooded areas near wetlands, but may range into grassland habitat (Lamond 1994).

Wood Frog	Prefers ponds in swamps, particularly those with many leaves on the bottom of the pond (Lamond 1994; Wright and Wright 1949); may also breed in marshes and ponds a short distance from woodlands (Lamond 1994); breeding begins in late March in the south and lasts about 3 weeks (Lamond 1994); eggs are laid in a round mass and are usually attached to a twig or branch underwater (Tyning 1990; Wright and Wright 1949); eggs hatch in 17 to 24 days (Lamond 1994; Wright and Wright 1949); the average time for tadpole transformation is 67 days, but ranges from 44 to 85 days (Lamond 1994; Wright and Wright 1949); adults usually remain in forest habitat but may be considerable distance from water (Lamond 1994).
Four-toed Salamander	Breed where sphagnum-fringed bog and permanent boggy ponds or spring fed creeks are available in or near damp wooded/mossy habitat (Chalmers and Loftin 2006, NRC 2007a). When not breeding, takes refuge under rotting logs, rocks, moss, and leaf litter. Found in moist, rich coniferous and occasionally deciduous forests during non-breeding times of the year (NRC 2007a).
Northern Leopard Frog	Wet sedge meadows, fields or forests, river floodplains, ponds, shallow marshes or weedy lake edges. During summer can be found in wet pastures or fields in large concentrations. Most selected habitats located within 100m from standing water.
Pickeral Frog	Requires cool water provided by groundwater seepage. Permanent woodland lakes, ponds, bogs or streams with shallow clear water and thick vegetation on borders. During summer can be found in wet pastures of fields in large concentrations. Most selected habitats located within 100m from standing water.
Green Frog	Moist woodlands near water, riparian areas; requires permanent bodies of water, lake or pond shores, stream banks, edges of shallow permanent or semi-permanent fresh water; home range size of 200m2
Mink Frog	Edges of lakes, ponds and streams, cold springs, open water with abundant lily pads, occasionally in bogs and marshes.
Red-backed Salamander	Terrestrial salamander living in deciduous hardwood (Howard 2003) and coniferous forests (AmphibiaWeb 2008). Adults found in leaf litter, under rocks, logs, or in small burrows. Require moist environment with soil pH that is not highly acidic (Howard 2003). Like many other amphibians, is negatively effected by high levels of acidity. The chronically lethal pH level for red-backed salamanders is between 3 and 4, and they are rarely found on soils with a pH of 3.7 or lower (Frisbie and Wyman 1995, Sugalski and Claussen 1997). Nests have occasionally been found in ponds that are near, but not directly adjacent to a forest (AmphibiaWeb 2008); however eggs are usually deposited under rotten logs (Howard 2003).
Two-lined Salamander	Prefer woodland or open habitats with sufficient cover provided by leaves, rocks, and logs (Vanwormer 2000). Typically found near woodland streams with rocky bottoms, springs, swamps, seeps, and rivers where they hide during the day beneath flat rocks and logs or under leaf litter along water's edge (ODNR 2006). Adults may remain active in springs, streams, or water laden soil where temperatures are above freezing in winter months or burrow deep beneath leaf litter where they become inactive (Vanwormer 2000). Larvae typically inhabit flowing waters of springs or streams, but have been found in lakes in one portion of their range (Vanwormer 2000). Abundance is positively related to increasing pH and water temperature (Barr and Babbitt 2002).

From Index #15: Amphibian Breeding Habitat (Wetland)

The following table summarizes important habitat requirements and chronology of amphibians that breed in non-forested wetland pools.

Species	Habitat Characteristics
Eastern (red-spotted) Newt	Breeds in permanent ponds (Bishop 1943), usually with dense submergent vegetation but occasionally in ponds with limited aquatic vegetation (Bishop 1941; Lamond 1994); breeding may also occur in swamps, roadside ditches, and in slow-flowing streams (Bishop 1943); breeding ponds are usually within or a short distance from forests, but occasionally they are in the open and considerable distance from forest habitat (Bishop 1943; Lamond 1994); breeds from April to June with adults that were aquatic over winter breeding earlier than those that wintered on land (Johnson 1989; Lamond 1994; Logier 1952); eggs are attached singly to submergent vegetation or rarely to stones (Bishop 1943) and hatch in 20 to35 days (Bishop 1943); the larval period lasts 2 to 3 months (Bishop 1943); transform into red efts that move out into the forest and also into adjacent open habitats.
Blue-spotted Salamander	Breeds in a wide variety of forest cover including deciduous, mixed, and coniferous upland and lowland stands (Lamond 1994); also breeds in ponds, marshes, and roadside ditches away from forest (Lamond 1994); breeding coincides with the first spring rains in March or early April, often before the pond is completely ice free (Lamond 1994); lays eggs singly or in pairs on leaves or other litter on the bottom of the pond (Lamond 1994); occasionally lays eggs in small clumps of 4 to 9 eggs and attaches the egg mass to a twig, similar to the egg laying habits of the Tremblay's salamander (Lamond 1994); eggs hatch in 3 to 4 weeks, and larvae begin to transform in mid July, occasionally as early as late June (Lamond 1994); complete transformation may take until early August (Lamond 1994); adults leave the pond shortly after breeding, young leave as soon as they transform (Lamond 1994); adults remain in forest habitat and hide under logs or burrow in the soil, some wander out into open habitat (Lamond 1994).
Spotted Salamander	Prefers well-drained, upland deciduous, mixed forest adjacent to permanent or temporary pools, marshes, wet meadows, ponds, or streams, adults hide under stones, boards or fallen logs.
Four-toed Salamander	Wet deciduous or coniferous woodlands with sphagnum moss; bogs, shallow marshes and fens, shallow woodland ponds.
American Toad	Breeds in temporary and permanent woodland pools, plus a wide variety of other habitats: marshes, ditches, open ponds, manmade ponds, tire ruts, and pools in agricultural and urban areas (Lamond 1994); has the widest breeding niche of Ontario's amphibians (Lamond 1994); prefers to breed in ephemeral pools but also breeds in permanent waters (Lamond 1994); breeds around mid-April until early May in the south (Lamond 1994); lays eggs in two strands which are wrapped around plants, rocks, and twigs (Wright and Wright 1949); eggs hatch in 3 to 12 days depending on water temperature (Wright and Wright 1949); tadpoles transform in 50 to 65 days, and young often leave the pond before the end of June (Lamond 1994; Wright and Wright 1949); adults may remain in forest habitat or move to open areas such as fields and residential areas (Lamond 1994; Wright and Wright 1949).

Gray Treefrog	Breeds in a wide variety of habitat including swamps, marshes, farm ponds, flooded farmland, and floodplains (Lamond 1994); uses temporary and permanent pools (Lamond 1994); breeding occurs from mid-May until early July (Lamond 1994); eggs are laid as floating packets and hatch within 5 days (Wright and Wright 1949); tadpoles take 40 to 60 days to transform into adults, with transformation usually occurring in late July or early August (Lamond 1994; Wright and Wright 1949); adults are arboreal and may remain in forest habitat or move to shrublands or rural residential areas (Lamond 1994).
Spring Peeper	Breeds mostly in pools in second growth forests or swamps, but also in isolated ponds with margins of emergents or shrubs (Lamond 1994); prefers ponds where there are trees or shrubs along the shoreline, but also uses areas of herbaceous emergents (Lamond 1994); egg-laying starts in late March or early April in the south (Lamond 1994); eggs are laid singly or in small groups on submerged twigs and leaves (Wright and Wright 1949); egg hatching takes about 15 days, depending on water temperature (Lamond 1994; Wright and Wright 1949); transformation takes 90 to 100 days, usually during the last half of June (Lamond 1994; Wright and Wright 1949); most adults remain in forest habitat, but some move to more open areas (Johnson 1989; Lamond 1994; Logier 1952).
Chorus Frog	Prefers shallow, temporary pools with abundant vegetation for breeding, but will occasionally use permanent ponds (Lamond 1994; Logier 1952; Wright and Wright 1949); breeds in woodlands, but also in disturbed habitats such as agricultural areas, shrublands, and meadows (Lamond 1994); in the Hamilton area, was more common in the southern portion of the area where there is less forest cover (Lamond 1994); requires areas with emergent or floating aquatic vegetation (Johnson 1989); breeding begins very early in the spring, often in late March and always by early April in the south (Lamond 1994); eggs are laid in small masses on submerged twigs (Logier 1952); egg hatching takes about 2 weeks depending upon water temperatures (Logier 1952); transformation is rapid (40 to 90 days) (Wright and Wright 1949) and may begin by the end of June (Logier 1952); adults usually remain in wooded areas near wetlands, but may range into grassland habitat (Lamond 1994).
Bull Frog	Breeds in deep, permanent pools and ponds as well as lakes, preferably with abundant emergent plants for foraging and cover/protection. Extensive areas of emergent shoreline vegetation are typically required for breeding (Lamond 1994) although some populations occur in more open water (Bury and Whelan 1984). Eggs are laid near shore in floating mats of jelly (Bury and Whelan 1984; Lamond 1994). It takes 2 to 4 years for tadpoles to transform into adult form frogs and another 3 to 5 years to mature to breeding adults (depending on geographic location). For a section of shoreline to function as bull frog habitat it must provide deep, permanent water, preferably with abundant emergent plants. Emergent plants support high densities of invertebrates which are consumed by larval frogs. The vegetation also provides hiding cover for tadpoles which are eaten by many predators. Water-level stability is also required to prevent desiccation of spawn during early summer and freezing during hibernation. The bull frog is a relatively sedentary species. Currie and Bellis (1969) reported a mean radius for home range activity in an Ontario pond of only 2.6 m. Therefore it is important to retain existing habitat whenever possible.

Mink Frog	Occupy rivers, lakes, ponds, pools, puddles, ditches, and streams, avoiding rapid currents and large wave activity, and preferring quiet bays and protected areas with a high abundance of aquatic macrophytes, especially floating water-lily (Nymphaeaceae) and pickerel weed (Pontederia cordata) or the edges of sphagnum mats (AmphibiaWeb 2008). Aquatic habitat is generally permanent in nature. Terrestrial activity is uncommon but may occur if the wetland is surrounded by damp, heavy forest with numerous bogs (Runesson 2007). Close proximity to water is always maintained.
Leopard Frog	Breeds in a variety of habitats including woodlands, but also dugout ponds and other manmade aquatic habitat, marshes, flooded fields, and floodplains (Lamond 1994); breeding generally occurs from mid-April to early to mid-May (Lamond 1994); eggs are laid in masses and hatch in about 3 weeks, but eggs that are laid later in late April or May hatch quicker due to increased water temperatures (Johnson 1989; Lamond 1994); tadpoles transform in 60 to 80 days depending on water temperatures (Johnson 1989; Lamond 1994); in the south, young leave the pond in late June or early July (Lamond 1994); adults disperse into damp meadows to feed (Lamond 1994). Grasses, sedges and rushes are common plants in areas inhabited by leopard frogs. Patches of shrubs and trees provide shade and cool, moist microclimates which serve as daytime resting areas. Presence of downed woody debris and other structures enhances the quality of the area as summer range by providing shade.
Pickerel Frog	Appears to require cool water where there is groundwater seepage, but not necessarily for breeding (Lamond 1994); has breeding habitat preferences similar to those of the leopard frog and may breed in the same ponds (Lamond 1994); breeding occurs in late April or early May (Lamond 1994); eggs are laid in clusters on submerged twigs in shallow water (Lamond 1994; Wright and Wright 1949); eggs hatch in 11 to 21 days (Lamond 1994); transformation takes about 80 days (Lamond 1994); adults disperse into damp meadows (Lamond 1994). Grasses, sedges and rushes are common plants in areas inhabited by leopard frogs. Patches of shrubs and trees provide shade and cool, moist microclimates which serve as daytime resting areas. Presence of downed woody debris and other structures enhances the quality of the area as summer range by providing shade.
Green Frog	Not particularly dependent on woodland pools, being more common in other habitats (Lamond 1994); requires permanent water bodies such as lakes, large marshes, ponds in rural areas, sewage lagoons, reservoirs, and slow-flowing streams and rivers (Lamond 1994); prefers areas where there is emergent and submergent vegetation along the shore (Lamond 1994); egg laying may begin in mid-May, but may continue until early August (Lamond 1994); eggs are laid in a mass over submerged plants (Logier 1952); eggs hatch in 3 to 6 days (Lamond 1994; Wright and Wright 1949); tadpoles require about a year to transform (Lamond 1994); therefore, this species must breed in permanent ponds to be successful (Lamond 1994); adults usually remain in the pond, or may move to other ponds.

From Index #25: Waterfowl Nesting Area

The following table summarizes the general habitat characteristics of waterfowl species that usually nest in upland areas adjacent to wetland and open water habitat.

Species	Habitat Characteristics
Canada Goose	Usually nests within 45 m of water, but occasionally considerable distances from water (Peck and James 1983); prefers vegetation less than 1 m tall unless it can find a hummock or mound to nest on (Reese et al. 1987); in the Hudson Bay Lowland, 87% of nests were on islands where the tallest vegetation was less than 1.8 m tall (Raveling and Lumsden 1977).
Green-winged Teal	Usually nests 35 to 55 m away from water; prefers dense vegetation and the nest is often at the base of a tree or shrub, in a clump of vegetation, or on a hummock (Peck amd James 1983).
American Black Duck	Most nests are near water or even over it, but nests have been found as far as 800 m from water (Peck and James 1983); in Maine, the mean distance of nests from water was 145 m (Longcore et al. 2000); prefers tall grasses and sedges for nesting (Peck and James 1983); will nest in upland forest containing beaver ponds or other water bodies (Ringelman and Longcore 1982a; 1982b).
Bufflehead	Forested lakes, ponds, sheltered bays of rivers and lakes during migration; nests in tree cavities and will use nest boxes.
Common Meganser	Clear, freshwater ponds, lakes, and rivers with forested edges; riverine wetlands , clear water is preferrerd and is probably necessary for feeding; nests in tree cavities and snags, but may use crevices in cliffs or nest on ground trees must be > 50 cm diameter (dbh) nests <200m from water, feed on fish.
Red-breasted Merganser	Lakes, ponds, rivers or streams in forested areas. Large deep swamps, rocky islands with shrubby growth or lake and river shorelines; nests on the ground under dense shrubbery, rofcks or driftwood <50m to water.
American Black Duck	Most nests are near water or even over it, but nests have been found as far as 800 m from water (Peck and James 1983); in Maine, the mean distance of nests from water was 145 m (Longcore et al. 2000); prefers tall grasses and sedges for nesting (Peck and James 1983); will nest in upland forest containing beaver ponds or other water bodies (Ringelman and Longcore 1982a; 1982b).
Mallard	Not very selective in its nesting habitat; nests may be over water, very near it, or 1.6 km away; nests in urban areas, farmland and natural habitat; no strong preferences for vegetation height or type near the nest (Peck and James 1983).
Northern Pintail	Usually nests within 90 m of water in Ontario (Peck and James 1983); in Alberta, nests were from less than 10 m to 1,500 m from water with 72% of nests within 100 m of water (Guyn and Clark 1999); nests have been found as far as 3.2 km from water but usually within 100 m (Bellrose 1980; prefers sparsely vegetated areas and often nests on bare soil, including agricultural land (Hochbaum 1944; Sowls 1955; Suchy and Anderson 1987).
Blue-winged Teal	Most nests are within 45 m of water, but they have been found 230 m away in Ontario (Peck and James 1983); Gammonley and Fredrickson (1995) stated that nests could be 1.6 km from water but that 80% were within 91 m of water and 95.6% were within 200 m of water; prefers short, dense grass cover for nesting, especially Kentucky bluegrass (Bennett 1938).

Northern Shoveler	Most nests are within 45 m of water, almost all are within 90 m (DuBowy 1996; Keith 1961; Peck and James 1983; Poston 1969; Sowls 1955); prefers perennial grasses and forbs about 50 cm in height (DuBowy 1996).
Gadwall	Most nests are within 45 m of water, but they may be as far away as 2.4 km (Gates 1962; Hines and Mitchell 1983a; Keith 1961; LeSchack et al. 1997; Peck and James 1983; Sowls 1955); prefers extremely dense, tall vegetation 1.5 to 1.8 m in height, often nettles, thistles, or shrubby areas (Duebbert 1966; Greenwood et al. 1995; Hines and Mitchell 1983a; 1983b; Keith 1961; Oring 1969; Sousa 1985; Sowls 1955; Vermeer 1968).
American Wigeon	Most nests are within 50 m of water (Bellrose 1980; Keith 1961; Vermeer 1970), but they have been found as far away as 180 m (Mowbray 1999a; Peck and James 1983); prefers dense cover of grasses or rushes at least 25 cm tall and avoids vegetation shorter than 15 cm (Mowbray 1999a).
Wood Duck	Breeding habitat is wooded swamps, shallow lakes, marshes or ponds; the presence of large diameter trees (> 40 cm) with cavities at least 9 cm wide and interiors at least 20 cm wide appear to be minimal nesting requirements (Johnsgard 1975); prefers cavities 1.5-12 m above water, but will use cavities ashore within 200 m of water, and will use suitable nest boxes (Palmer 1976); the entrance should also be protected from weather and the cavity well drained; require availability of overwintering seeds or nuts, native herbaceous plants, and aquatic or aerial insects for food; breeding cover should include trees and/or shrubs, and trees should have low branches and preferably be flooded; water should be no more than 45 cm deep, should be still or slow-moving, and should be available through the fledging period; the presence of herbaceous aquatic plants is highly desirable, as are resting sites for broods (Johnsgard 1975).
Hooded Merganser	Small, forested, freshwater wetlands with emergent vegetation is preferred breeding habitat; low-elevation freshwater lakes, ponds, sloughs, and slow-moving rivers are all used; prefers wooded, clear-water streams and the wooded shorelines of lakes; availability of small fish and inverebrates, and tree cavities are major factors influencing breeding distribution (Johnsgard 1975); ideal nesting habitat is flooded shoreline with standing drowned trees and with snags and stumps interspersed, but also nests in other locations where there are hollow trees (or nest boxes) (Palmer 1976).
Common Goldeneye	Occurs on large rivers, inland lakes and marshes, and the Great Lakes; prefers areas with aquatic vegetation, but also uses areas devoid of vegetation (Dennis and Chandler 1974; Dennis et al. 1985); eats mostly aquatic insects, crustaceans, and molluscs, but also aquatic plants (Eadie et al. 1995); in Ontario also eats zebra mussels, amphipods, and snails during migration (Custer and Custer 1996; Hamilton et al. 1994; Wormington and Leach 1992).
Trumpeter Swan	Nests on a wide variety of freshwater marshes, ponds, lakes, and occasionally rivers; tend to prefer large, shallow lakes, but will also select small farm ponds (< 1 ha), glacial potholes, backwater sloughs, beaver ponds, bogs, and hardwood swamps with abundant submergent macrophytes (Chara spp. and Potamogeton spp.); they avoid acidic, stagnant, or eutrophic waters. Habitat requirements include: ~ 100 m for takeoff; accessible forage (e.g. Elodea, Sagittaria, Najas, Nitella,

Potamogeton, Sparganium, and Zizania); shallow, stable levels of unpolluted, fresh water; emergent vegetation, and a muskrat or beaver lodgehouse, island, or other structure for nest site; and low levels of human disturbance. The highest productivity occurs in waters with: highly irregular shoreline; depth < 1.2 m; emergent vegetation; abundant and diverse communities of aquatic plants; early ice-off; multiple nest sites available; and little human disturbance (Mitchell and Eichholz 2010).

From Index #26: Raptor Nesting, Foraging and Perching Habitat

The following table summarizes the general habitat requirements of species in this guild.

Species	Habitat Characteristics
Osprey	Osprey nests are almost always associated with large lakes or marshes (Penak 1983) and profitable foraging areas must be within 10 km of the nest (Poole 1989; Houston and Scott 2001). Ospreys typically maintain one or more alternate nests, which may be adjacent to active nests or more than 1 km away. Most nests are along forested shorelines, on islands, or on structures over water. Most Ontario nests have been in mixed forest habitat, but nests also occur in coniferous and deciduous stands (Peck and James 1983). Occasionally, nests are situated in dry habitat 1 km or more from water. Dead coniferous trees are preferred for nesting; nests are usually at the top of the tree, but occasionally are in crotches. Less frequently, live or deciduous trees are used. Mature, isolated trees are usually selected as opposed to trees in a group. Most of Ontario's nests are 9 to 18 m from the ground, with extremes of 0.6 to 30 m (Peck and James 1983). In the Lindsay area, Ospreys often nest on stumps in water. Nests are occasionally situated on hydro towers and poles, in heronries, and on artificial nesting structures (Peck and James 1983). Almost all nests have an unobstructed view, and there is usually a tall perch nearby for the male (Van Daele and Van Daele 1982). Nests are used year after year, sometimes for decades (Judge 1983; Reese 1977; Singer 1974).
Bald Eagle	Most Bald Eagle nests are associated with large lakes, more rarely with small lakes or large rivers. For nesting, shelter, roosting, feeding and normal behaviour, they require an area of about 255 ha (James 1984a). Lakes with <5 km of shoreline are not used unless there is a larger lake within 1 km (Brownell and Oldham 1984). This species shows a distinct preference for islands because they have often not been burned or logged and offer many large trees suitable for nests (James 1984a). The birds appear to have no particular preference for mixed, coniferous, or deciduous forest (Peck and James 1983), although forest structure is important. Bald Eagles nest in mature or old-growth forest with discontinuous or open canopy, usually where there is 20 to 50% crown coverage (Gerrard et al. 1975; Haywood and Ohmart 1983; Peterson 1986). They show a preference for live trees and conifers in Ontario (Peck and James 1983). In the northwest, white pine is preferred, although red pine is used; north of the range of white pine, trembling aspen is used almost exclusively (Brownell and Oldham 1984). Shape, diameter, and structure of the nest tree are more important than species. Large trees (dbh 60 cm or greater) with crotches large enough to support the huge nest are essential (Brownell and Oldham 1984). Bald Eagles are fish-eating birds which forage in areas supporting abundant fish populations. Productive areas of open water or deep-water marshes are required to supply fish in the quantities needed by these birds to feed growing young. Nests are usually built in large trees near shore or over water. Artificial nesting structures

may also be used. Nests are reused and become extremely large as new material is added each year. Remoteness from human disturbances may be an important parameter in the selection of nest sites for most birds, although some select sites in areas of relatively high human activity. Most Ontario nests are 15 to 22 m from the ground, occasionally higher, in a crotch 1.5 to 6 m from the top of the tree (Peck and James 1983). The nest tree must provide an unobstructed view and flight path in all directions (Brownell and Oldham 1984); as such, Bald Eagles typically nest in "super canopy" trees (i.e., taller than their neighbours). Bald Eagles also require snags, or a number of tall dead, partially dead or living trees for perching, usually within 400 m of a nest tree (James 1984a; Caton et al. 1992). Nests are added to each year and may be used for decades. Alternate nests may also be built and used in alternate years. These nests are usually close to each other, but may be as far apart as 5 km (Stocek and Pearce 1981; Brownell and Oldham 1984). Bald Eagles will occasionally use artificial nesting structures or old Great Blue Heron nests (Bortolotti et al. 1988; Forsythe 1996; Gostomski and Matteson 1999). In Ontario, Bald Eagles show a preference for live trees and conifers (Peck and James 1983). In the northwest, white pine is preferred, although red pine is used; north of the range of white pine, trembling aspen is used almost exclusively (Brownell and Oldham 1984). Shape, diameter, and structure of the nest tree are more important than species. Large trees (dbh 60 cm or greater) with crotches large enough to support the huge nest are essential (Brownell and Oldham 1984).

From Index #27: Woodland Raptor Nesting Habitat

The following table provides a summary of the key habitat requirements of woodland raptors. Important habitat characteristics include forest type and size, nesting tree species and characteristics, use of alternate nests, nest-site and territory fidelity, spacing of pairs, understory density, and prey.

Species	Habitat Characteristics
Great Horned Owl	Deep, deciduous, mixed or coniferous forests or large woodlots; mixed forests and fields; swamps; woodlands near large streams or pond; near dumps; feeds in open areas like fields or pastures.
Sharp-shinned Hawk	Nests almost exclusively in coniferous forests, seldom in mixedwood stands (Peck and James 1983); preferred forests are very dense, with 80% or more canopy cover, are even-aged, and typically 25 to 50 years old (Apfelbaum and Seelbach 1983; James 1984a; Moore and Henny 1983; Reynolds 1983; Reynolds et al. 1982); plantations are frequently used (Wiggers and Kritz 1991); it nests in upland and lowland stands, but appears to prefer wetlands or areas near lakes or watercourses (Peck and James 1983); nests are usually at the edges of forest (James 1984a); forests 20 to 30 ha in size or larger appear to be preferred (James 1984a; Sandilands 2005), but it appears to be adapting to fragmented habitat and nests in urban areas in Montreal (Coleman et al. 2002); usually nests in spruce, hemlock, cedar, or pine (Peck and James 1983); most nests are 6 to 10.5 m from the ground, usually at the trunk a few metres from the top of the tree (Peck and James 1983); selects trees with particularly dense crowns in areas of high tree density (Apfelbaum and Seelbach 1983; Flood and Bortolotti 1984; Reynolds et al. 1982); usually builds a new nest every year, but almost always within 100 m of the previous year's nest, even if another

	pair is involved (Bildstein and Meyer 2000); territory size is about 4 ha, but home range may be 200 to 1300 ha (Bildstein and Meyer 2000; Reynolds 1983; Reynolds and Wight 1978); nests tend to be spaced 1.8 to 6 km apart (Bildstein and Meyer 2000; Reynolds and Wight 1978); foraging usually occurs in the upper canopy and adjacent forest openings (Taylor and Taylor 1979); eats primarily small birds which are caught in flight (Bildstein and Meyer 2000).
Cooper's Hawk	Nests mostly in deciduous forests, less frequently in mixedwoods (Peck and James 1983); has a preference for mature white pine stands in Ontario (James 1984a); in western North America and Wisconsin, it often nests in coniferous plantations and even in cities (Murphy et al. 1988; Rosenfield and Bielefeldt 1993; Rosenfield et al. 1995); in Ontario, it is usually associated with forests 50 ha in area or larger, but may occasionally use woodlots as small as 4 ha or even smaller (Sandilands 2005); tends to nest in intermediate-aged and mature forests; prefers upland forests; tends to nest in forest interior, but may nest in small forest fragments and even isolated trees (Rosenfield and Bielefeldt 1993; Rosenfield et al. 1995); requires a canopy height of at least 15 m (Titus and Mosher 1981); nests are often within 300 m or less of water (James 1984a; Titus and Mosher 1981); about 70% of Ontario nests are in deciduous trees (Peck and James 1983); preferred species are maple, beech, and hemlock (Peck and James 1983); most nests are 9 to 13.5 m from the ground (Peck and James 1983); nests in conifers are usually in upper branches against the trunk, nests in deciduous trees are mostly on horizontal, forked branches (Apfelbaum and Seelbach 1983); territories are used traditionally, with a new nest usually being built within 100 m of the previous one (Asay 1987; Reynolds and Wight 1978); the territory size is 6 to 50 ha (Reynolds and Wight 1978; Rosenfield and Bielefeldt 1992), but the home range is 200 to 1800 ha (Craighead and Craighead 1956; Reynolds 1983); nests are spaced about 1.8 m apart, rarely as close together as 700 m (Asay 1987); hunts at the edge of forests and in forest openings (Toland 1986); eats mostly small birds which are caught in flight (Rosenfield and Bielefeldt 1993).
Northern Goshawk	Nests in mature deciduous, mixed, and coniferous forests, including plantations (Peck and James 1983); inhabits closed-canopy forests with few shrubs or saplings in the understory, avoids areas with dense shrubs (Reynolds and Meslow 1984); nests mostly in forests 100 ha in area or larger, but may nest in forest fragments as small as 10 ha (Reynolds et al. 1982; Squires and Reynolds 1997; Woodbridge and Detrich 1994); in the east, mostly confined to large forests (Bosakowski and Speiser 1994); nests in the interior; most stands used for nesting are 100 or more years old (Reynolds 1983); prefers stands with many conifers, but seldom nests in them (Peck and James 1983); 70% of Ontario nests are in deciduous species (Peck and James 1983); preferred species are birch, pine, poplar, beech, and maple (Peck and James 1983); nests are at a main crotch or forks in branches at the trunk (Peck and James 1983); most nests are 9 to 12 m from the ground (Peck and James 1983) a short distance below the crown of the tree (Moore and Henny 1983; Speiser and Bosakowski 1987, 1989); selects the largest trees available for nesting (Moore and Henny 1983); may build a new nest every year or use one for 2 or 3 years (Reynolds and Wight 1978); may have alternate nests sites 60 to 400 m away (Squires and Reynolds 1997); territory size is 5 to 10 ha (Bartelt 1974; Reynolds and Wight 1978), but home ranges are at least 200 ha (Craighead and Craighead 1956) to 4,600 ha (Iversen et al. 1996; Reynolds 1983; Squires and Reynolds 1997); nests

average over 5 km apart, occasionally as close together as 2.4 km (Reynolds and Wight 1978); hunts in flight under the forest canopy (Squires and Reynolds 1997); feeds on medium-sized birds and mammals (Squires and Reynolds 1997); important prey are Ruffed Grouse and snowshoe hare (Squires 2000; Squires and Reynolds 1997).

Red-shouldered Hawk

Nests mostly in mature mixed and deciduous forests, occasionally in pine plantations (Peck and James 1983); in Ontario and southwestern Quebec, it prefers maple-beech-hemlock forests (Campbell 1975; Dent 1994; Morris et al. 1982; Sharp and Campbell 1982); lowland forests are preferred in many areas, including parts of Ontario (James 1984a); requires a closed canopy (>70%) with a minimum of shrubs and saplings (Armstrong and Euler 1983; Bryant 1986; Campbell 1975); appears to prefer forests 50 to 70 ha in area and larger in south-central Ontario (Sandilands 2005), but occasionally nests in smaller stands; in Waterloo Region, Sharp and Campbell (1982) reported it nesting in woodlands 4 to 97 ha in area, but the smaller woodlots were abandoned first when the species started to decline; also in Waterloo Region, Bryant (1986) found that it nested successfully in woodlots as small as 5 ha and concluded that forest structure was more important than size; James (1984a) concluded that it required a minimum of 10 ha of forest, but would probably prefer 100 ha; the amount of forest cover within the region that the nest is located may be more important than individual patch size (Robbins et al. 1989); considered a forest-interior species by some authors (Freemark and Merriam 1986), but most nests are near a natural opening such as a wetland (Bosakowski et al. 1992; Titus and Mosher 1981); presence of nearby water is essential (Campbell 1975; Dent 1994; Sharp and Campbell 1982; Titus and Mosher 1981); nests in stands 100 to 200 years old (Armstrong and Euler 1983; Campbell 1975; Morris et al. 1982; Sharp and Campbell 1982); almost all nests are in deciduous trees, with beech, maple, and yellow birch being preferred (Peck and James 1983); most nests are 11 to 16 m from the ground in tree forks or main crotches of branches (Peck and James 1983); the nest tree is usually larger than average in the stand, and often extends above the canopy (Morris 1993); usually selects trees with a dbh of 50 cm or greater (Portnoy and Dodge 1979); the nest is usually at the bottom of the canopy or below it (Armstrong and Euler 1983; Morris et al. 1982; Titus and Mosher 1981); has a very high site-tenacity for the territory (Craighead and Criaghead 1956; Risley 1982; Sharp and Campbell 1982); territories and home ranges coincide and average 60 to 200 ha in area (Crocoll 1994); nests may be as close together as 220 m (Risley 1982), but end to be 1.2 to 2 km apart (Crocoll and Parker 1989; Howell and Chapman 1997); hunts from a perch in the forest or along a forest clearing (Armstrong and Euler 1983; Bushman and Therres 1988; Toland 1986); about half of the diet is amphibians and snakes (Crocoll 1994); also eats voles and shrews (Crocoll 1994).

Broad-winged Hawk

Nests mostly in intermediate-aged (Armstrong and Euler 1983), dense mixed and deciduous forests, less frequently in coniferous stands and plantations (Peck and James 1983); prefers lowland stands or forests that are close to swamps or open water (Peck and James 1983); regularly thought to prefer forests 100 ha in area or larger, but there appear to be few data on forest-size requirements; nests are often at the edge of forests or near an opening (Armstrong and Euler 1983; Goodrich et al. 1996); prefers stands with a canopy height of 21 m or more (Armstrong and Euler 1983); nests are usually on a slope in a live deciduous tree (Armstrong and Euler 1983); preferred nest tree species are birch, poplars, maple, oak, and pine (Peck and James 1983); most nests are 7.5 to 12 m from the ground (Peck and James 1983);

	usually builds a new nest each year (Keran 1978; Matray 1974); prefers trees with a dbh >45 cm (Matray 1974; Titus and Mosher 1981), but may nest in trees as small as 30 cm dbh (Rosenfield 1984); territory and home range appear to be the same, and are 100 to 200 ha in area (Crocoll and Parker 1989; Fitch 1958); there is a high rate of homing to territories, but birds tend to nest 100 to 400 m from the previous nest (Keran 1978; Matray 1974); hunts from a low perch such as a tree, fence post, or power line (Armstrong and Euler 1983; Goodrich et al. 1996); less dependent on forests for hunting than many others in this guild; hunts on edges and in clearings when it does hunt in forests (Goodrich et al. 1996); eats mostly amphibians, insects, and meadow voles (Goodrich et al. 1996).
Barred Owl	Nests in mature deciduous and mixedwood forests (Peck and James 1983); rarely uses pure coniferous stands (Mazur and James 2000); needs large numbers of trees larger than 50 cm dbh, although it may nest in trees as small as 34 cm dbh (Allen 1987; Elody and Sloan 1985; Mazur and James 2000; Olsen et al. 2006); inhabits both upland and lowland forests (Mazur and James 2000); considered a forest-interior species that avoids edge by some authors (Bosakowski et al. 1987), but in other areas frequently nests near clearings, clear-cuts, or near woodland trails (Mazur et al. 1997; Olsen et al. 2006; Yannielli 1991); needs very large forests 100 to 400 ha minimum size, but has nested in forests as small as 40 ha (Allen 1987; Askins et al. 1987); may prefer water near the nesting area, but it does not appear to be essential (Bosakowski et al. 1987; Elody and Sloan 1985; Mazur and James 2000); is an indicator of old-growth forest (Mazur and James 2000); requires forests with few shrubs and saplings in the understory (Bosakowski et al. 1987; McGarigal and Fraser 1984; Nicholls and Warner 1972); nests mostly in natural cavities, but occasionally on old stick nests or squirrel drays (Peck and James 1983); all reported nests in Ontario have been in deciduous trees: balsam poplar, beech, and white birch (Peck and James 1983); most nests are 7.5 to 10.5 m from the ground (Peck and James 1983); nest trees are usually dead or decadent (Apfelbaum and Seelbach 1983; Peck and James 1983); has a home range of about 250 to 800 ha, with extremes of 38 to 2,678 ha (Elody and Sloan 1985; Mazur et al. 1998; Nicholls and Fuller 1987; Nicholls and Warner 1972); in ideal habitat, nests are at least 2 km apart; has very high nest-site and territory fidelity (Mazur and James 2000); territory boundaries remain the same even if different owls are present (Mazur and James 2000); hunts mostly in swamps from a perch, but also in marshes and meadows (Mazur and James 2000); eats mostly voles, cottontails, and hares, but also some squirrels, amphibians, turtles, small birds, and insects (Mazur and James 2000).
Merlin	Merlins prefer edge environments with scattered trees for perches and open terrain for hunting birds and insects on the wing. The species commonly nests in forests with scattered clearings or adjacent open habitat such as grasslands, wetlands, lakes or burns. Merlins typically nest in conifers, particularly where there is a clear view of the surroundings, and often use the abandoned stick nests of other raptors (Gahbauer 2007). In Ontario, Merlins favour islands and peninsulas where they can hunt passerines crossing open water. Their foraging strategy relies on speed and agility; Merlins often hunt by flying fast and low, typically less than 1 metre above the ground. Merlins may roost communally, but usually singly in conifer trees; tall trees with greater crown volume are preferred (Sodhi et al. 2005).

Northern Saw-whet Owl	Nests in upland and lowland deciduous, mixed, and coniferous stands, with a slight preference for stands containing conifers (Cannings 1993; Peck and James 1983); requires intermediate-aged to mature stands (Cannings 1993); forest size is not important (Cannings 1993); appears to be most abundant in coniferous and mixedwoods with a well-developed middle canopy of conifers 2 to 4 m tall (Cannings 1987; 1993; Swengel and Swengel 1986); nests in natural and woodpecker cavities (Peck and James 1983); most nests are in live deciduous trees (Peck and James 1983); most nests are 3.5 to 6 m from the ground (Peck and James 1983); home range and territory sizes are not well known; home ranges may be about 150 ha (Cannings 1987; 1993; Marks et al. 1989); hunts from perches in forest clearings or along forest edges (Bondrup-Nielsen 1977; Cannings 1993; Catling 1972; Johnsgard 1988); eats mostly small woodland-dwelling mammals such as deer and white-footed mice, red-backed voles, woodland jumping mice, and small shrews (Cannings 1993); also eats other small mammals, preferring prey that does not weigh much more than 40 g (Cannings 1987; 1993); may eat small numbers of birds and insects (Cannings 1993).
Red-tailed Hawk	Prefers relatively small patches of mature and older forest or fencerows with trees that abut large open areas; nests are large, with good access either on or near the forest edge; prefers to hunt from a prominent perch in or adjacent to open areas such as old fields, meadows, burns or cutovers; diet includes small mammals, grouse, small birds, snakes and insects (Szuba 2007a).

From Index #28: Reptile Nesting and Overwintering Areas

The following table summarizes the general habitat requirements of species in this guild.

Species	Habitat Characteristics
Midland Painted Turtle	Quiet, warm shallow water with abundant aquatic vegetation such as ponds, large pools, streams, ditches, swamps, marshy meadows: eggs are laid in sandy places. Usually in a bank or hillside or in fields: bask in groups; not territorial.
Snapping Turtle	Permanent, semi-permanent fresh water, marshes, swamps or bogs, rivers and streams with soft muddy banks or bottoms. Often uses soft soil or clean dry sand on south-facing slopes for nest sites. May nest at some distance from water. Often hibernate together in groups in mud under water. Home range size approximately 28ha.
Northern Map Turtle	Large bodies of water with soft bottoms and aquatic vegetation; basks on logs or rocks or on beaches and grassy edges, will bask in groups; uses soft soil or clean dry sand for nest sites; may nest at some distance from water, home range size is larger for females (about 70ha) than males (about 30ha) and includes hibernation, basking, nesting and feeding areas; aquatic corridors (e.g. stream) are required for movement not readily observed.
Eastern Musk Turtle	Aquatic, except when laying eggs; shallow slow moving water of lakes, streams, marshes and ponds; hibernates in underwater mud, in banks or in muskrat lodges; eggs are laid in debris or under stumps or fallen logs at waters edge; often share nest sites; sometimes congregate at hibernation sites; not readily observed.

Five-lined Skink	Moderaltely dense or open deciduous or mixed woodlands with logs and slash piles; damp spots under logs, leaf litter, or sawdust; open talus slopes, barren rock, sandy beaches of Lake Erie and Lake Ontario; breeds in forest floor litter; lays and protects eggs under rocks and logs; forages in open woodlands, in sandy areas, along shores of lakes and islands; hibernates under rock piles, in rock crevices, under logs and in stumps.

From Index #32: Open Country Bird Breeding Habitat

The primary requirements of these open country birds are highly variable, but they represent an open-habitat guild because they either require extensive areas of open habitat or have very specific habitat requirements. The following table outlines the general habitat requirements of grassland birds of conservation concern:

Species	**Habitat Characteristics**
Northern Harrier	Prefers large, open fields with minimal shrub or tree coverage (Peck and James 1983); seems to prefer open areas that are 30 ha in area or larger, but occasionally nests in smaller habitat patches (Walk and Warner 1999); also nests in marshes, bogs, and fens (Peck and James 1983); in fields, grass cover taller than 50 cm is preferred (Kantrud and Higgins 1992) and the nest is often situated on a small knoll (Sandilands 2005); requires 250 to 640 ha of suitable foraging habitat in Ontario (Cadman 1993); usually nests are within 250 m of a high population of voles (Simmons and Smith 1985).
American Kestrel	Inhabits open to semiopen areas covered by short ground vegetation, including meadows, grasslands, deserts, early old field successional communities, open parkland, agricultural fields, and both urban and suburban areas (Smallwood and Bird 2002). Irrespective of dominant vegetation form present in the open area, breeding territories are characterized by either large or small patches covered by short ground vegetation, with taller woody vegetation either sparsely distributed or lacking altogether (Bird and Palmer1988 in Smallwood and Bird 2002). Suitable nest trees and perches for hunting are required. Typical breeding habitat are large (>25 ha) pasture or recently fallowed field, with 1 or few isolated large dead trees for nesting and several potential perches (trees or utility lines) (Smallwood and Bird 2002). Prefers nesting cavities surrounded by large (>20 ha) open patches covered with short ground vegetation with adequate hunting perches nearby (Smallwood and Bird 2002). Also nests along woodlot edges, or in partially wooded habitats if suitable hunting patches are available (Smallwood and Bird 2002).
Horned Lark	Large, open areas with short grasses, ploughed fields, agricultural lands, pastures, prairie, golf courses, cemetaries, airports, areas of little vegetation, tundra, seashore; needs a bare patch of exposed ground within territory.
Short-eared Owl	Prefers grasslands of various heights, densities and species composition (Clark 1975; Peck and James 1983); also nests in bogs, fens, and marshes (Cadman 1994; Peck and James 1983) and on extensive sand dunes (Weir 1989); appears to require about 75 to 100 ha of contiguous open habitat (Austen et al. 1994); nests tend to be in grass 30 to 50 cm tall, occasionally in vegetation as tall as 1 m (Kantrud and Higgins 1992); nests are often on knolls elevated 1 or 2 m above the remainder of the field (Clark 1975).

Upland Sandpiper	Nests in old fields, hayfields, pastures, and at airports (Peck and James 1983); may have originally been associated with short-grass prairie, also occurs on alvars; appears to require about 25 to 40 ha of open habitat, or even as much as 100 to 200 ha (Bollinger 1995; Jones and Vickery 1995; Vickery et al. 1994; Walk and Warner 1999); prefers uniform grass cover 15 to 30 cm in height, avoids areas where grass height exceeds 60 cm (Kantrud and Higgins 1992); presence of residual vegetation from previous years is important (Kirsch and Higgins 1976); needs perches for displaying such as fenceposts (White 1983).
Le Conte's Sparrow	Nest in variety of open habitats, often found on drier edges of marshes and wet meadows in grasses, sedges, alder, willow, dense graminioid marsh, with or without shrubs.
Prairie Warbler	Shrub-land, mixed pine-oak barrens, old pastures, hillsides with scattered red cedars; avoids thick woods and benefits from cutting and burning of forests.
Grasshopper Sparrow	Often associated with areas of poor soils such as abandoned gravel pits or areas where bedrock is close to the surface (Vickery 1996); appears to prefer areas where vegetation is sparse, yet where there is a thick thatch cover from previous year's vegetation (Patterson and Best 1996; Smith 1963; Vickery 1996; Wiens 1969); prefers grassy areas, but will tolerate 10 to 20% shrub cover (Vickery 1996); prefers scattered shrubs or tall, sturdy, herbaceous vegetation stalks that can be used as singing perches (Swanson 1996; Vickery 1996); more inclined to occupy large tracts of habitat than small fragments (Herkert 1994, Vickery et al. 1994); minimum area requirements in Maine about 100 ha (Vickery et al. 1994), in Illinois about 30 ha (Herkert 1994); often associated with areas of poor soils such as abandoned gravel pits or areas where bedrock is close to the surface (Vickery 1996); nests are built on the ground (Vickery 1996); may nest singly or in small colonies of one or two dozen pairs; occurs in habitats as small as 10 ha when a single pair is nesting (Herkert 1991; Swanson 1996), but colonies are often associated with habitat patches 100 ha or larger and the size of patch that it requires varies regionally (Davis 2004; Johnson and Igl 2001; Vickery et al. 1994).
Vesper Sparrow	Prefers dry grass fields, with some shrubs or similar structure, and is found in open habitats, including old fields, shrubsteppe, grasslands, reclaimed surface mines, crop and haylands, weedy roadsides, and natural meadows (Jones and Cornely 2002). Breeds in dry habitats with short, sparse, and patchy herbaceous vegetation; some bare ground; and low to moderate shrub or tall forb cover (Jones and Cornely 2002). Nests located on the ground under or at base of vegetation, including grass, forbs, weeds, grass tussocks, shrubs, small trees; beside logs and dead branches; and under dead branches (Jones and Cornely 2002).
Savannah Sparrow	Inhabits grassy meadows, cultivated fields (especially alfalfa), lightly grazed pastures, roadsides, coastal grasslands, sedge bogs, edge of salt marshes, and tundra; avoid areas with extensive tree cover; at the northern edge of the range, this species usually inhabits dwarf willows or birches and feeds readily in conifers; dense ground vegetation, especially grasses, and moist microhabitats are favored (Wheelwright and Rising 2008).
Western Meadowlark	Prairies, grasslands >10ha in size.

From Index #33: Shrub/Early Successional Bird Breeding Habitat

The following table outlines the general habitat requirements shrubland birds of conservation concern:

Species	Habitat Characteristics
Yellow-breasted Chat	Prefers old fields with a relatively high density of deciduous shrubs and saplings (Austen et al. 1994; Peck and James 1987); occasionally nests in open deciduous woods and clearings in forests (Peck and James 1987); very dense areas overgrown with shrubs and vines are preferred (Eckerle and Thompson 2001) but will tolerate areas of open grass if dense shrubs are nearby (Johnston and Odum 1956).
Black-billed Cuckoo	The Black-billed Cuckoo prefers groves of trees, forest edges, and thickets; frequently associated with water (Hughes 2001). In eastern Canada, the Black-billed Cuckoo is usually found along the edges and in clearings of young deciduous and mixed deciduous-coniferous woods; abandoned farmland with trembling aspen, poplar, and birch; brushy hillsides and pastures, roadsides, and fencerows; orchards and berry patches; hawthorn thickets; also in wet areas, often among willows near edges of bogs and marshes, or on lake and river shores; and occasionally in urban areas such as parks, ravines, golf courses, and residential gardens (Peck and James 1983, Pistorius 1985, Eaton 1988 all in Hughes 2001).
Conneticut Warbler	Well-spaced black spruce swamps with good ground cover of Labrador Tea; moist woodlands with well-developed understorey for nesting, aspen or polar.
Wilson's Warbler	Boggy areas with cedar, tamarack or spruce, swampy brushy land, streamside thickets and tangles, wet, wooded high shrubs or low deciduous trees.
Northern Cardinal	Open woodlands with heavy underbrush; woodland edges; urban areas, parks, groves, gardens, swamps or streamside thickets; brushy tangles; nests in dense shrub, small trees, tangles of vines, thickets and briars.
Prairie Warbler	Shrub-land, mixed pine-oak barrens, old pastures, hillsides with scattered red cedars; avoids thick woods and benefits from cutting and burning of forests.
Lincoln's Sparrow	Muskegs, bogs, swamps; regenerated stands following cutting or fires, hedgerows, spruce forests with clearings; willows, alder thickets; low brushy growth with openings of grass or sedge, edges of lakes, rivers.
Tennessee Warbler	Brushy, semi-open land, grassy openings in coniferous, deciduous or mixed woods with dense shrubs and scattered clumps of young deciduous trees; treed fens or boggy areas, dry pine plantations and beach ridges.
Palm Warbler	In summer: bogs; during migration: open places, especially weedy fields and borders of marshes and woodlands; nests on ground in grass clump, territories are 1-2ha in size, less common in south, particularly where wetlands have been eliminated.
Willow Flycatcher	In general, prefers moist, shrubby areas, often with standing or running water. In central and eastern U.S. and Canada, uses both wet sites and dry, brushy upland sites (Campbell 1936, Aldrich 1953). Breeds in a variety of usually shrubby, often wet habitat (Sedgwick 2000). Nests sites are selected within the same territory every year and are generally located at outer edge of shrub or thicket and near edges of shrub clumps close to water (Berger and Parmalee 1952). Across its range, willow shrubs are frequently selected for nesting, but many other species of shrubs, and occasionally trees are used (Sedgwick 2000).

Field Sparrow	Prefers successional old fields, woodland openings and edges, roadsides and railroads near open fields. Field Sparrows breed in brushy pastures and second growth scrub of the eastern United States and southern Canada (Carey et al. 1994). Does not breed close to human habitation, but is occasionally found in Christmas tree farms, orchards, and nurseries (Peterjohn and Rice 1991, in Carey et al. 1994). Will nest in old fields directly after a burn or within a year of cultivation, but only if there is scattered woody vegetation with elevated perches in the territory.
Yellow-bellied Cuckoo	Carolinian, Great Lakes –St. Lawrence forest zones, open woodlands with dense, shrubby undergrowth, scrub-land with small trees, orchards, parkland, edges of agricultural areas, overgrowth, weedy fields, steambanks with dense thickets.
Eastern Screech Owl	Open woodland, orchards or shade trees in urban areas, small woodlots, prefers mature deciduous trees, reguires trees >30cm dbh for nesting and roosting, confined largely to southern Ontario as a breeding bird, small woodlots are acceptable if scattered trees are available over several hectares.
Northern Hawk Owl	Open, coniferous or mixed woods with clearings, forest edges, swamps, or muskegs: dense bushy areas; burned woodland with standing stumps, diurnal habits, nest in old woodpecker holes.
House Wren	Edges of woods, rivers, swamps or clear cuts; openings with shrubs and thickets, deciduous woods, shrubbery, gardens, orchards, swampy woodlands, nests in trees with dbh >25cm; territories may be no more than 0.4 ha in size.
Carolina Wren	Shrub-land, open deciduous woodland thickets and tangles along streams, woodland edges with slash piles, in winter found in sheltered stream valleys, deep ravines with nearby food source.
Philapedphia Vireo	Open, deciduous, coniferous or mixed forest with trembling aspen and alders; amoung or adjacent to aspen groves; forest edges; streamside willow and alder thickets; burned over areas or clearings; small (0.5ha) territory.
Northern Mockingbird	Pastures, gardens or orchards with adible fruit-bearing shrubs, woodland edges; hedgerows; groves of large trees; low, dense woody vegetation needs elevated perches
Brewster's Warbler	A hybrid between a Golden-winged Warbler and a Blue-winged Warbler.
Clay-coloured Sparrow	Found in open shrubland, thickets along edges of waterways, second-growth areas, and forest edges and burns (Root 1968 in Knapton 1994). Occupies willow and birch shrubbery in montane meadows and forest-grassland interfaces (Semenchuk 1992 in Knapton 1994). In East, occupies broad range of habitat types, from young pine plantations to abandoned fields grown up to shrubs and small trees, regenerating burns, and forest openings (Knapton 1987). Birds are occasionally found in suitable habitat in cities (McNicholl 1977 in Knapton 1994). Substantial preference for locating nest sites in snowberry (Knapton 1994).
Brown Thrasher	Inhabits thickets and hedgerows in deciduous forest clearings and forest edge in the eastern part of North America (Cavitt and Hass 2000). Winters in hedgerows, gardens, thickets, and brushy woodland edges. Breeds in brushy open country, thickets, shelter belts, riparian areas, and suburbs. Pairs usually nest low in a tree or shrub, occasionally on the ground (Cavitt and Hass 2000).

Eastern Towhee	Eastern Towhee spend much of their time near or on the ground in dense habitats and scrubby growth (Greenlaw 1996). Occupies habitats characterized by dense shrub–small tree cover near ground and well-developed litter layer (Morimoto and Wasserman 1991). Dense, low cover may be continuous or discontinuous with patches of more open ground (Greenlaw 1996). Overstory trees may or may not be present, and if present, open-canopy (woodland) situations are favored (Greenlaw 1996). Occupies mid- to late stages of secondary succession with greatest densities in old field thickets and later stages of second growth, but sometimes present in climax forest as well, where understory is well developed (Leck et al. 1988 in Greenlaw 1996). On mountainsides, more likely to be found on dry, sunny southern and southwestern slopes than on shaded, cool northern slopes. Examples of habitats used include shrub–small tree thickets in old field sere, mixed upland broadleaf forest with or without conifers, second-growth oak-hickory forest, climax mixed oak forest-woodlot, white oak savannah, pine barrens woodland, brushy clearings in spruce-fir forest and shrub-grass balds (Appalachian Mtns.), old dune scrub, hammocks and swamp edges with thick undergrowth, pine flatwoods with saw palmetto undergrowth, oak scrub, and riparian thickets (Greenlaw 1996). Nest sites are variable, but typically located in relatively dry spots on ground, usually at base of upright vegetation such as low shrubs, small trees, or grass and forb clumps (Greenlaw 1996).
Blue-winged Warbler	Prefers early to midsuccession habitats, especially abandoned farmland and forest clearings (Gill et al. 2001). Breeding location preference includes forest/field edges, often shaded by large trees (Gill et al. 2001). Nests typically located 30m outside forest edge, rarely to 20 m inside forests (Gill et al. 2001).
Golden-winged Warbler	Golden-winged Warblers use a broad range and variety of plant communities and regardless of vegetation type consistently use patches of herbs, shrubs, and scattered trees, plus a forested edge (Martin et al. 2007). They thrive initially with appearance of shrubby, early-succession fields that follow logging, fire, or abandoned farmlands (Confer 1992). Territories generally have patches of dense herb growth without cover by woody plants, patches of dense shrubs that covered about 50% of the territories, and are bordered by trees (Confer 1992). Nests are usually on the ground, often at the base of a cluster of leafy plant material, however nests sometimes built in a tussock of grass or sedge (Confer 1992).

From Index #34: Area-Sensitive Bird Breeding Habitat

The following table summarizes the key habitat requirements of breeding birds susceptible to forest fragmentation. However, the information provided is still relatively general and more detailed data may be required to determine potential impacts of development on area-sensitive birds.

Species	Habitat Characteristics
Yellow-bellied Sapsucker	Nests in deciduous and mixed upland and lowland forests (Peck and James 1983); prefers intermediate-aged and mature stands with a preference for aspen (Kilham 1971; Lawrence 1966; 1986); appears to need at least 30 to 50 ha of forest in southern Ontario; in Michigan, its presence was associated with forest size and in Saskatchewan it was most common in large forests or in areas with a high percentage of forest cover within 5 km (Crozier and Niemi 2003; Hobson and Bayne 2000); nests in the interior of smaller woodlots but appears to prefer to nest at the edge of larger forests (Crozier and Niemi 2003; Hobson and Bayne 2000; Steeger et al. 1996), possibly because aspen tends to be more common on forest edges.

Red-breasted Nuthatch	Typically found in intermediate-aged to mature coniferous stands, including plantations (Cadman et al. 2007), but also found in mixed woods with a strong coniferous component (Peck and James 1987; Ghalambor and Martin 1999); in Ontario, nest cavity excavations range from 3-9 m above ground on average, and deciduous trees are preferred for nesting over coniferous trees (Peck and James 1987).
Pileated Woodpecker	Nests in mixed and deciduous stands, occasionally in conifers (Peck and James 1983); needs mature forest and trees at least 40 cm dbh for nesting and roosting (Bull et al. 1992; D'Eon and Watt 1994; Naylor et al. 1996); presence of mature poplars is important in much of its range (Peck and James 1983); usually nests in interior but occasionally on edges or in open situations; occasionally nests in hydro poles with a large enough diameter; appears to need about 30 to 50 ha of forest, but may incorporate several smaller woodlots into its home range and therefore may not be a true area-sensitive species (Bushman and Therres 1988; Naylor et al. 1996; Schroeder 1982); James (1984b) suggested that 70 to 200 ha of forest was required per pair but this may have been based on data from western North America where territories are much larger; based on breeding pair densities in Ontario and other eastern sites, territories may be as small as 30 ha (Bull and Jackson 1995; Speirs and Orenstein 1975).
Winter Wren	Nests mostly in coniferous and mixed forests, rarely in deciduous forests (Peck and James 1987); in deciduous forests, may be associated with American yew ground cover (pers. obs.); prefers swamps (Peck and James 1987); territories in upland forests are usually adjacent to wetlands or water (Peck and James 1987); prefers mature forests with lots of fallen logs and is typically associated with old-growth forest (Barrows 1986; Cumming and Diamond 2002; Haney 1999; Hejl et al. 2002b; Sinclair et al. 2003), but may nest in younger stands and even clear cuts with residual brush and standing trees (Hejl et al. 2002b; nests in the interior in the south, but often near creeks or margins of ponds and lakes on the Shield; appears to need about 30 ha of forest (Hejl et al. 2002b).
Veery	Nests in deciduous and mixed swamps, seldom in coniferous swamps (Peck and James 1987); may also nest in wet, shrubby fields and alder thicket swamps (Peck and James 1987); prefers younger woodlands with denser shrub and sapling layer than other woodland thrushes (Bertin 1977; Dilger 1956; Moskoff 1995b; Sousa 1982) nests throughout the forest (Moskoff 1995b; Peck and James 1987); appears to need about 10 to 20 ha of forest; in the mid-Atlantic states, maximum probability of detection occurred in woodlands 250 ha and larger, the probability of detection declined by 50% in woodlands 20 ha, and the three smallest woodlots that it occurred in on two or more occasions were 24.1, 11.3, and 9.3 ha (Robbins et al. 1989).
Blue-headed Vireo	Nests in coniferous and mixed stands, rarely in deciduous forest (James 1979; Peck and James 1987); strongly associated with hemlock in Algonquin Park (Martin 1960) and New Jersey (Benzinger 1994); but may use a wide variety of coniferous species (James 1998); tends to nest near small openings or edges of wetlands and lakes (James 1998) and it has also nested in open habitats such as pasture and a dry, rocky ridge (Peck and James 1987); in the south, it occurs mainly in large, mature coniferous plantations that have developed an understory (James in Cadman et al. 1987); originally appeared to be restricted to forests 100 ha or larger in the south, but results of the second breeding bird atlas indicate that it has become much

	more widespread and common in the Great Lakes-St. Lawrence Forest Region south of the Shield, but it continues to be restricted to large forest tracts in the Carolinian Zone (OBBA 2007); the increase may be related to maturation of coniferous plantations and the maturity of habitat may be as important or more important than patch size; it is area-sensitive in Ontario as indicated by its scarcity in the Carolinian Zone, but patch size requirements are uncertain; in Quebec, patches that were large enough to support a territory (5 ha) were unoccupied (Langevin and Lafontaine in Gauthier and Aubry 1996).
Northern Parula	Nests in mature, moist deciduous, coniferous, and mixed forests in the north with a preference for tall, mature coniferous forests with spruce, hemlock, and fir in bogs and swamps where Usnea lichen is common (Moldenhauer and Regelski 1996); in the south, appears to prefer extensive riparian forests (Graber et al. 1983; Moldenhauer and Regelski 1996); requires Usnea lichen for nest material in most cases (Peck and James 1987); usually nests near water (rivers, sloughs and wetlands, lakes), which may be within forest or at forest edge (Moldenhauer and Regelski 1996); presence of Usnea and water may be more important in determining nesting location than distance from edge; in the south, probably requires 100 ha of forest (James 1984c); Lynch and Wigham (1984) found that forest size was one of the most important factors in determining its presence in Maryland and Whitcomb et al. (1981) found few in forests smaller than 70 ha in Maryland; Blake and Karr (1984) found it in isolated woodlands as small as 65 ha in Illinois; Robbins (1979) suggested that 100 ha was the minimum area required for a self-sustaining population, although it occurred in smaller woodlands.
Black-throated Blue Warbler	Nests in mixed and deciduous forest with a dense undergrowth of mostly deciduous shrubs and saplings (Peck and James 1987); hemlocks are preferred in mixed forests (James 1984c); prefers older second-growth or mature forest (James 1984c); in New Hampshire, occupied sites were characterized by a greater proportion of deciduous vegetation and denser understory (Doran and Holmes 2005); presence of the warblers was positively related to shrub density in New Hampshire, although territories were not located where shrub density was highest (Steele 1992); Quebec birds were also more common where shrub cover was high (Darveau et al. 1992); most nests are near openings such as road edges, shorelines and forest clearings (Peck and James 1987); typically found only in large tracts of forest (Holmes 1994); generally reported to require 100 ha of forest, but this is based on results reported by Robbins et al. (1989) for the mid-Atlantic states and their conclusions were derived from only 13 observations of the species; this warbler has recently expanded its range in southern Ontario (OBBA 2007) suggesting that it is not as area sensitive as suggested by Robbins et al. (1989); in Quebec, Darveau et al. (1992) studied Black-throated Blue Warblers in forests that were 12 to 20 ha in area indicating that it inhabited much smaller woodlands there, although the landscape was 60% forested; in southern Ontario, it may require 30 to 50 ha of forest cover based on recent distribution (OBBA 2007).
Black-throated Green Warbler	Nests most often in coniferous forests, less often in mixed forests, rarely in deciduous stands (Peck and James 1987); James (1984c), however, stated that it preferred mixed woods over coniferous forests; prefers balsam fir and hemlock (James 1984c); nests throughout the forest and at forest edges and near roads or water (Peck and James 1987); appears to be area sensitive in southern Ontario and may require about 30 ha of forest although additional information is required; Morse (1993) felt that it was area sensitive in isolated woodlands and Askins and Philbrick (1987) noted that it

	disappeared from several small (<100 ha) northeastern forests that became isolated even though habitat within them did not change; considered area sensitive by Freemark and Collins (1992) but not by Bushman and Therres (1988) or Robbins et al. (1989).
Blackburnian Warbler	Nests in coniferous and mixed woods as well as spruce-tamarack bogs (Peck and James 1987); has also nested in recent burns (Peck and James 1987); occasionally nests in deciduous forests (Morse 1994); prefers balsam fir and hemlock (James 1984c); nests in both upland and lowland forests (James 1984c); nests throughout the forest; Freemark and Collins (1992) were uncertain if the Blackburnian Warbler was area-sensitive; it appears to be area sensitive in southern Ontario given its distribution pattern (OBBA 2007); in the south, appears to require about 30 to 50 ha of forest; in Minnesota, nests on islands as small as 1 ha if tall white pine or black spruce are present (Howe 1979; Rusterholz and Howe 1979).
Cerulean Warbler	Nests in intermediate-aged and mature deciduous stands, less frequently mixed stands (Peck and James 1987); most Ontario nests were at edges or near clearings (Peck and James 1987); in eastern Ontario, 59% of nests were within 30 m of a gap within contiguous forest (Oliarnyk and Robertson 1996); in Illinois, it is most abundant in extensive bottomland forests (Graber et al. 1983); it appears to prefer forests with small openings in the canopy where dense undergrowth occurs (Hamel 2000a; Oliarnyk and Robertson 1996); all authors agree that it is area sensitive, but the estimates of minimum forest size differ (Hamel 2000a); estimates include 20 to 30 ha in Ohio where isolated tracts of 8 to 10 ha are avoided, 700 ha in the mid-Atlantic states, and 1,600 ha in the Mississippi Alluvial Valley of Tennessee (Peterjohn and Rice 1991; Robbins et al. 1989, 1992); in Minnesota, it occurred more frequently in woodlands larger than 16 ha than those smaller than 16 ha and occurred only in tracts smaller than 16 ha if they were mesic (Bond 1957); in Virginia, Wood et al. (2006) found that it increased in abundance with amount of forest cover in the landscape and decreased with amount of forest edge; breeds in woodlots as small as 10 ha in eastern Ontario (Hamel 2000a) in a landscape that is largely forested; its response to habitat fragmentation may reflect factors that co-vary with patch size, such as cowbird parasitism (Robinson et al. 1995; Hamel et al. 1998); McCracken (1993) suggested that it probably required tracts larger than 100 ha in Ontario; the fact that it also breeds in much smaller tracts in eastern Ontario indicates that its requirements for patch size may vary depending upon the amount of forest cover in the landscape; Hamel (2000b) recommended that further research be undertaken on this subject.
Ovenbird	Nests in deciduous, mixed, and coniferous forests (Peck and James 1987) that are intermediate or mature in age (James 1984c); may use coniferous plantations where hardwoods are regenerating or coniferous stands adjacent to deciduous forest (Graber et al. 1983); prefers upland habitat (Graber et al. 1983; James 1984c); but also nests in wet habitats (Peck and James 1987); nests throughout the forest but many Ontario nests were at woodland edges or near clearings, or beside paths and logging roads (Peck and James 1987); Robbins (1979) and Robbins et al. (1989) suggested that the Ovenbird required 100 to 885 ha of contiguous forest to breed successfully; James (1984c) and OMNR (2000) stated that the Ovenbird required about 70 ha of forest in Ontario; near Ottawa, Lee et al. (2002) surveyed 31 woodlands ranging in size from 3 to 122.7 ha and three 80-ha plots and found Ovenbirds in 25 of the 34 patches; surrounding forest cover and patch size were both significant predictors of Ovenbird abundance and these two parameters were

	not correlated; in Missouri, Sweeney and Dijak (1985) surveyed woodlands 2.8 to 27.9 ha in area for Ovenbirds and found them in over 60% of stands, but this was in a heavily forested landscape; in Saskatchewan, Mazerolle and Hobson (2002) studied Ovenbirds in forest fragments ranging in size from 9 to 40 ha, with a median of 11.25 ha, in a landscape with 26% forest cover and only one sampled woodlot was over 40 ha; they concluded that forest fragmentation was not affecting food abundance but differences in vegetation structure and cowbird parasitism in fragments could affect success; in the same study area Mazerolle and Hobson (2004) suggested that forest fragments either had larger areas of unsuitable habitat or are less saturated by Ovenbirds than contiguous forests; Van Horn and Donovan (1994) suggested that smaller forest tracts may not be suitable due to edge effects, isolation, and diminished habitat quality; in Peterborough County, Burke and Nol (1998) studied Ovenbirds in forests 12 to 2,353 ha in size and Ovenbirds were virtually ubiquitous, occurring in 66 of 69 woodlands surveyed; small woodlots appeared to be poor habitats for Ovenbirds in terms of food supply and birds avoided nesting near edges making small woodlots unsuitable; requires a minimum of about 20 ha of forest for nesting, but Burke and Nol (1998) suggested that optimum habitat did not occur until there was about 20 ha of interior habitat (100 m from edge), or approximately 80 ha of forest.
Canada Warbler	Nests in upland and lowland mixed, coniferous, and deciduous forests (Peck and James 1987); nests in both dense and open stands but usually nests in open stands, in clearings, or on woodland edges (Peck and James 1987) ;occurs in both swamps and upland forests, with a slight preference for upland stands (Peck and James 1987); often breeds in cedar swamps (Conway 1999); in New York, most abundant in areas heavily logged 5 to 15 years previously (Webb et al. 1977); may also nest in shrubby areas (Peck and James 1987); Freemark and Collins (1992) noted that it was considered area sensitive by some authors but not by others; considered area sensitive in Ontario by OMNR (2000) but not by James (1984c); Robbins et al. (1989) considered it area sensitive in the mid-Atlantic states, but their information was based on only 22 observations; probably requires about 30 ha of forest in southern Ontario (OMNR 2000) and this estimate seems reasonable based on its current distribution (OBBA 2007).
Scarlet Tanager	Nests in deciduous and mixed forests, predominantly in deciduous woodlots (Peck and James 1987); prefers intermediate-aged and mature stands; may nest near the interior but also nests on edges almost equally (Peck and James 1987); Mowbray (1999b) stated that it was a forest-interior and area-sensitive species that was highly sensitive to forest fragmentation, but suggested that only 10 to 12 ha were required to support a viable population; nest record information from Ontario demonstrates that it is not a forest-interior species (Peck and James 1987); appears to require at least 20 ha of forest.

From Index #35: Marsh Bird Breeding Habitat

The following table summarizes the general habitat requirements of species in this guild.

Species	Habitat Characteristics
Pied-billed Grebe	Prefers marsh-lined ponds, lakes, and rivers (Peck and James 1983), but also common on beaver ponds (Sandilands 2005); usually nests in dense stands of cattails, bulrushes, bur-reeds, spike-rushes, or arrowheads (Glover 1953); occasionally nests among emergent shrubs (Glover 1953); may also nest in open ponds with a minimum of emergent vegetation (Sandilands 2005); prefers to nest in water depths of 30 to 100 cm (Peck and James 1983); nest is a floating mass of aquatic vegetation (Peck and James 1983); not area sensitive, frequently nesting on ponds on wetlands smaller than 2 ha, down to 0.2 ha (Faaborg 1976; Yocum et al. 1958); however, Brown and Dinsmore (1986) and Gibbs et al. (1991) felt that it seldom nested on ponds smaller than 5 ha; Chabot and Francis (1996) concluded that it was found mostly on larger wetlands with considerable open water based on preliminary Marsh Monitoring Program results, but this program does not monitor smaller inland wetlands.
American Bittern	Nests mostly in marshes, but occasionally in bogs, fens, and old fields (Peck and James 1983); preferred marshes have extensive emergent and submergent vegetation and a high interspersion of open water and vegetation (Gibbs et al. 1991); nests are usually built in emergents such as cattails, bulrushes, and sedges in water as deep as 45 cm (Peck and James 1983); usually nests in marshes 10 ha or larger, but occasionally in wetlands as small as 1 ha (Brown and Dinsmore 1986; Gibbs et al. 1991; Graber et al. 1978; Riffell et al. 2001).
Virginia Rail	Nests in dense vegetation in shallow water, including marshes, beaver ponds, ditches, and openings in swamps (Peck and James 1983); preferred vegetation is cattails, bulrushes, sedges, or grasses (Peck and James 1983); avoids areas without standing water; prefers water depths <10 cm but tolerates water as deep as 25 cm (Eddleman et al. 1988; Griese et al. 1980; Zimmerman 1977); may nest successfully in very small wetlands (Berger 1951), but usually associated with marshes 1 ha or larger.
Sora	Nests in marshes with emergents and shallow water, occasionally in damp meadows and bogs (Peck and James 1983); wetland size and type of emergents are not important where it is common such as Ontario (Berger 1951), but prefers wetlands 2 to 5 ha in some areas (Melvin and Gibbs 1996) and is restricted to large marshes in areas where it is uncommon to rare (Andrle and Carroll 1988; Laughlin and Kibbe 1985); prefers water depths of 8 to 20 cm, rarely to 40 cm (Griese et al. 1980; Johnson and Dinsmore 1986; Lowther 1977); avoids areas without standing water; prefers wetland edges and interfaces between vegetation and open areas (Glahn 1974; Johnson and Dinsmore 1986; Melvin and Gibbs 1996).
Red-necked Grebe	Permanent freshwater lakes with a fringe of aquatic emergent vegetation, marshes, impoundments or sewage lagoons with > 4 ha of open water, protected marshy areas or bays in larger lakes, nest greatly affected by wave action of boats and other human disturbances.
Northern Shoveler	Short grassy areas such as meadows or hay fields, close to open water with lots of aquatic vegetation, marshes, sloughs, nests typically 20-60 m from water but may be up to 1.6 km away, migrate in small flocks.

Redhead	Shallow Cattail/bulrush marshes, lakes and ponds and fens, preferred nesting usually close to shallow water (most within 2m), but can be found as far as 270m from waters edge.
Ring-necked Duck	Small (<4ha) wetlands with some surrounding woody vegetation, often in heavily forest areas, shallow swamps, marshes and bogs with emergent vegetation, near reedy lakes or rivers; during migration also rivers, larger lakes, ponds with marshy edges.
Common Moorhen	Nests mostly in cattail marshes, but also among bulrushes, sedges, burreeds, sweet gale, arrowhead, and reed grass (Peck and James 1983); prefers water 40 to 50 cm deep and an approximate 50:50 ratio of open water to emergents (Eddleman et al. 1988; Fredrickson 1971); most nests are among emergents, built of emergents, in water depths of 20 to 90 cm, and are 2.5 to 90 cm above water (Peck and James 1983); appears to prefer small and medium-sized marshes to large ones (Bent 1926; Ripley 1977); Chabot and Francis (1996) suggested that it preferred larger marshes in Ontario where there was much open water and abundant floating plant cover based on preliminary Marsh Monitoring Program results.
American Coot	Nests mostly in cattail marshes, but also uses bulrushes, sedges, bur-reeds, reed grass, and willow shrubs (Peck and James 1983); prefers wetlands with a 50:50 ratio of emergents to open water and population densities decline with increasing vegetation cover (Allen 1985; Barnes and Nudds 1990; Gorenzal et al. 1982; Fredrickson 1970; Fredrickson et al. 1977; Friley et al. 1938; Kiel 1955; Sutherland 1991; Weller and Spatcher 1965); most nests are well concealed in emergents, are 9 to 30 cm over water averaging 50 to 70 cm deep, and are 1 to 30 m from open water (Allen 1985; Peck and James 1983); appears to be associated with very large marshes in Ontario (Sandilands 2005), but elsewhere may nest on wetlands smaller than 1 ha (Allen 1985; Brown and Dinsmore 1986), but selects larger marshes than are generally available (Brown and Dinsmore 1986; Nudds 1982).
Solitary Sandpiper	Open, wet northern coniferous forest woodlands, wetlands, ponds, lakes, nests in abandoned bird nests in trees.
Lesser Scaup	Tundra ponds, inland boreal wetlands, Great Lakes inland marshes, open grassy areas near water with little emergent vegetation.
Ruddy Duck	Open habitat near wetlands with emergent vegetation, nest situated above shallow water in reeds, cattails, sedges. Somewhat colonial; returns to same place to nest year after year.
Common Moorhen	Nests mostly in cattail marshes, but also among bulrushes, sedges, bur-reeds, sweet gale, arrowhead, and reed grass (Peck and James 1983); prefers water 40 to 50 cm deep and an approximate 50:50 ratio of open water to emergents (Eddleman et al. 1988; Fredrickson 1971); most nests are among emergents, built of emergents, in water depths of 20 to 90 cm, and are 2.5 to 90 cm above water (Peck and James 1983); appears to prefer small and medium-sized marshes to large ones (Bent 1926; Ripley 1977); Chabot and Francis (1996) suggested that it preferred larger marshes in Ontario where there was much open water and abundant floating plant cover based on preliminary Marsh Monitoring Program results.

American Coot	Nests mostly in cattail marshes, but also uses bulrushes, sedges, bur-reeds, reed grass, and willow shrubs (Peck and James 1983); prefers wetlands with a 50:50 ratio of emergents to open water and population densities decline with increasing vegetation cover (Allen 1985; Barnes and Nudds 1990; Gorenzal et al. 1982; Fredrickson 1970; Fredrickson et al. 1977; Friley et al. 1938; Kiel 1955; Sutherland 1991; Weller and Spatcher 1965); most nests are well concealed in emergents, are 9 to 30 cm over water averaging 50 to 70 cm deep, and are 1 to 30 m from open water (Allen 1985; Peck and James 1983); appears to be associated with very large marshes in Ontario (Sandilands 2005), but elsewhere may nest on wetlands smaller than 1 ha (Allen 1985; Brown and Dinsmore 1986), but selects larger marshes than are generally available (Brown and Dinsmore 1986; Nudds 1982).
Sandhill Crane	Nests mostly in bogs and fens (Peck and James 1983), but occasionally in marshes (Armbruster 1987; Stephen 1978); vegetation type near the nest does not appear to be overly important (Armbruster 1987); requires large wetlands, usually 200 to 400 ha in area (Armbruster 1987; Riley 1982; Stephen 1978), occasionally smaller (Peck and James 1983); usually nests at least 1 km from any human activity (James 1985).
Wilson's Phalarope	Nests among grasses and sedges at the margins of wetlands or on islands (Cadman in Cadman et al. 1987; Peck and James 1983); prefers grasses about 30 cm tall and avoids vegetation taller than 60 cm (Kantrud and Higgins 1992); the nest is usually near water (<15 m) in a dry location, but one Ontario nest was 45 m away from water (Peck and James 1983); forages in shallow water or on mudflats in wetlands (Bent 1927; Brooks 1967a; 1967b; Johnsgard 1981); more frequent in small wetlands than large ones; also nests at sewage lagoons (Cadman in Cadman et al. 1987).
Black Tern	Nests in marshes dominated by cattails, but also bulrush, sedge, and bur-reed marshes (Peck and James 1983); prefers a 50:50 ratio of emergents to open water, but also nests in small openings within extensive emergents (Austen et al. 1994; Dunn 1979; Dunn and Agro 1995; Gerson 1987; Shuford 1999); rarely nests where water depths are <0.5 m; prefers water depths of about 1 m near the nest (Dunn 1979; Dunn and Agro 1995; Gerson 1987; Mazzocchi et al. 1997; Scharf 1999); the nest is a floating or anchored mass of aquatic vegetation (Peck and James 1983); it is area-sensitive, rarely occurring in marshes smaller than 20 ha (Dunn 1996).
Yellow Rail	Breeds primarily in sedge-dominated wetlands where the substrate remains damp (up to 15 cm of standing water throughout the breeding season) (Bookhout 1995; Cadman et al. 2007); nests are built beneath dead, procumbent vegetation, on the ground or as much as 15 cm above it (Bookhout 1995); in Ontario, nests have been found in sedge-dominated Great Lakes coastal wetlands, wet hayfields, sedge-dominated inland wetlands, and James/Hudson Bay coastal sedge fens and sedge meadow marshes (Cadman et al. 2007).
Marsh Wren	Marsh Wrens are widespread in Ontario south of the Canadian Shield, but abundance is limited by the availability of suitable habitat, particularly in southwestern and eastern Ontario (Tozer 2007); breeds both singly and in loose colonies (Peck and James 1987); nests mostly in cattail marshes, occasionally in bulrushes, horsetails, bur-reeds, and emergent grasses (Peck and James 1987); may use cattails early in the breeding season and other species of emergent vegetation later (Kroodsma and Verner 1997); nests are usually over water, but occasionally just over damp ground

	(Peck and James 1987); nests are elevated 0.2 to 1.5 m above water, usually in cattails (Peck and James 1987); it is questionable if the Marsh Wren is a true colonial species as the males are aggressively territorial (Kroodsma and Verner 1997); apparent coloniality may be due to polygyny, with some males attracting 2 or 3 females into their territory (Kroodsma and Verner 1997).
Sedge Wren	Largely confined to southern Ontario, from Algoma and Nipissing Districts south, and to the extreme west in the Rainy River and Kenora areas (Brewer 2007); nests mostly in sedge fens, occasionally in bogs, rarely in cattail marshes, also in old field and hayfields (Peck and James 1987); nests are on the ground or as high as 0.9 m from the ground (Peck and James 1987); most frequently, nests are in clumps of sedges, but they may be at the base of a shrub (Peck and James 1987); usually not associated with standing water, but usually in imperfectly or poorly drained areas (Peck and James 1983); mostly nests singly and has very low site fidelity, seldom occurring at the same location in subsequent years (Herkert et al. 2001); colonies are more likely to be long-term, with one area in Illinois supporting Sedge Wrens for at least 14 years (Herkert et al. 2001); a colony in a fen at Luther Marsh, Ontario was present for at least 10 years (Sandilands 1984); degree of coloniality uncertain as males defend territories that may change considerably during the breeding season, and males may be serially or simultaneously polygynous and females may be serially polyandrous (Herkert et al. 2001).
Green Heron	Occurs throughout southern Ontario, ranging sporadically north to Lake Nipissing (Sandilands 2007b); typically nests singly in shrubs in or adjacent to wetlands, but occasionally nests in small colonies; nests are bulky structures, built of sticks or aquatic emergents, and placed in deciduous shrubs or trees, less often in conifer trees, and sometimes in emergent vegetation in marshes; forages in marshes, ponds, and along drainage ditches and sluggish watercourses (Sandilands 2007b).
Common Loon	Breeds throughout Ontario, with the exception of the Carolinian region in the south where suitable habitat has always been limited by the scarcity of lakes; nests are simple mats of vegetation at water's edge on marshy shorelines or islands; when nesting on small lakes, breeding birds may forage on neighbouring lakes as well (Jones and Timmermans 2007).

From Index #36: Terrestrial Crayfish Preferred Habitat

Crocker and Barr (1968) provided a description of the burrows of these two crayfish as well as other crayfish species. Field workers should be aware of the differences among types of burrows, and also that certain other species of crayfish that are not of conservation concern may also use burrows under certain circumstances.

Species	**Habitat Characteristics**
Chimney Crayfish	The chimney crayfish regularly constructs a burrow with an oval cavity near the surface with one to three entrance tunnels capped by clay chimneys which may or may not be structured, depending upon soil types. The burrowing is similar to that of the meadow crayfish but, in addition, there is usually a straight narrow tunnel leading directly downward from some point in the cavity of the burrow. These extend at least 30 to 60 cm below the cavity (Crocker and Barr 1968). The burrows of the chimney crayfish differ from those of Orconectes immunis in having a resting

	chamber close to the surface of the ground, and from those of the meadow crayfish in having a deep escape tunnel leading down from the chamber (Crocker and Barr 1968). Burrows may be found in moist clay among cattails and bulrushes, but also in relatively hard, dry soil where the water table is far below the surface and the vegetation is primarily terrestrial (Guiasu et al. 1996).
Meadow Crayfish	At Long Point, meadow crayfish construct shallow burrows in wet, open fields or damp marsh areas. There is usually an oval cavity 8 to 15 cm below the surface of the ground, with two or three narrow entrance tunnels leading upward (see figures in Crocker and Barr [1968]). Where the colony is dense, the burrows are sometimes connected by short tunnels, which probably result from chance meeting of two burrowing crayfish. Mud chimneys from this species have not been observed in open fields, but chimneys appear to be always constructed over entrances occurring among cattail stalks in marshes (Crocker and Barr 1968).Grow and Merchant (1980) added some details on the design and habitat parameters of the meadow crayfish's burrows. The burrows have several openings at the surface each of which may or may not be surrounded by a chimney. The chimneys may range in height from a low mound to a tower more than 30 cm high. At some point below the water table, the vertical tunnel ends in an ovoid horizontal chamber, and there may be an additional chamber projecting laterally from the vertical tunnel that may function as a summer retreat or food storage area. Chambers were constructed in clay and silty clay soils. Burrow depth can range from 15 cm to more than 5 m and is determined by the groundwater level or the depth to which the soil freezes in winter. Dissolved oxygen concentrations in the burrow are very low and almost anoxic. Consequently, crayfish may rely on the interface between water and air within the burrow to obtain sufficient oxygen, and the same appears to be true for the chimney crayfish.

From Index #38: Bat Migratory Stopover Area

The following table summarizes the general habitat requirements of species in this guild.

Species	Habitat Characteristics
Hoary Bat	Roosts in trees with dense leaf foliage, forest edges of hedgerows; also in city parks, do not use caves; feeds over water or open areas; migrates south in winter, prefers to feed over wetlands or open fields; a solitary species.
Silver-haired Bat	Prefers temperate, hardwoods with ponds or streams naearby; roosts in tree foliage or hollow snags, buildings or caves; somewhat solitary except for small maternity or colonies; usually found in hollow trees, found in forested areas, near watercourses; migrates south in winter.
Eastern Red Bat	Roosts in leafy trees such as elm and maple but also may use corridors; forage habitat includes over streams, near lights and along field and forest edges; migrates south in winter, prefers to feed over wetlands or open fields; a solitary species.